ENGINEERING NEWS-RECORD

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Engineering News-Record is a consolidation of *Engineering News* and *Engineering Record*, effected in 1917.

Engineering News was founded in 1874 by George H. Frost, as the *Engineer and Surveyor*, which title subsequently became the *Engineer, Architect and Surveyor*, then *Engineering News and American Railway Journal* and finally *Engineering News*, under the successive editorships of D. McN. Stauffer, Arthur M. Wellington and Charles Whiting Baker.

Engineering Record was established in 1877 by Henry C. Meyer as the *Plumber and Sanitary Engineer*. The name was subsequently changed to the *Sanitary Engineer, Engineering and Building Record* and, finally, to *Engineering Record*. During his ownership of the paper, Mr. Meyer was directly responsible for the editorial policy. John M. Goodell became editor in 1902, and was succeeded by E. J. Mehren.

The Contractor was consolidated with *Engineering News-Record* in 1918.

E. J. Mehren became editor of *Engineering News-Record* at the time of the consolidation in 1917, and was succeeded by the late Frank C. Wight in 1924.

The staff of *Engineering News-Record* consists of—
New York: F. E. Schmitt, M. N. Baker, C. S. Hill, V. T. Boughton, W. G. Bowman and H. W. Richardson.
Chicago: E. E. R. Tratman, W. W. De Berard.
San Francisco: N. A. Bowers.

A New Pilot

FREDERICK E. SCHMITT, managing editor, has been appointed Editor of *Engineering News-Record*. It is no light matter for the publishers to make such an announcement. *Engineering News-Record* is a great institution. It is the property, in a legal sense, of the McGraw-Hill Publishing Company. Actually it belongs to the engineering profession and the construction industry as a whole. It is the chosen instrument of information of thousands of engineers and constructors who have written, and are writing, their names large in the annals of America's physical development. These men, living and passed, have elevated the paper to its present place of leadership. They have made it great by their confidence in it, by their enthusiasm, their counsel and help, and by the use of its columns as the means of sharing with others their contributions to engineering thought. That is why the paper truly belongs to the engineering profession and the construction industry.

The publishers are not unmindful that their task has been an important one—that of selecting and training the men who could deserve this splendid acceptance and support. It is in further performance of this responsibility that this announcement is made. A successor is needed to Frank Wight, of enduring memory, who will worthily carry on the virile work of a line of eminent predecessors.

In appointing Mr. Schmitt, the publishers do so without any faltering or misgivings. He has won his spurs by a long and brilliant journalistic career. He has the confidence of engineers and constructors. He has the ardent support and loyalty of his associates on the staff. We pass to him the mantle of Stauffer, of Wellington, of Baker, of Goodell, of Mehren and of Wight in the full confidence that he will carry the paper to new heights and that our action, in making him editor, will have the hearty approval of the reader. JAMES H. MCGRAW.

The Simple Truths

IT WAS fine discrimination on the part of Prof. H. F. Moore to choose Robert Hooke and his familiar "law" as the theme of his presidential address to the American Society for Testing Materials. Two and three centuries ago, in the time of Hooke, there were formulated some of the broad generalizations necessary to the growth of physical science and its derived engineering arts. Whether exact or approximate, these generalizations come to us at this late day as axioms, as "laws," so plain to every eye that they must have been clear, it seems to us, even to men of primitive times. Yet for long ages they were unknown, until the craftsman found in his puzzling experiences those traces of like behavior and correspondence that gave him the clue to a basic relationship. We work with more complex problems today, and when we think of Nature's laws we have in mind more abstruse matters than *"Ut tensio sic vis."* For this very reason, however, it is of value to think back to those simpler truths discerned many years ago, of which after all the fabric of technical thought is woven.

Antique Equipment

ILLUSTRATIONS of construction equipment in the engineering text books of ten years ago remind one of the tintypes in an old family photograph album. The contour of the faces somewhat coincides with those we see today, but the disguise in all other respects is complete. Consider a few of the comparisons between yesterday and today in the field of construction equipment. The usual power shovel in 1920—then it was invariably a steam shovel—had a boom and a dipper stick, but little else that we recognize on the modern machines. There were few crawler units, and those that did appear were of fragile construction. There were no alloy-steel dippers, no unit-cast steel frames, no cut gears running in oil. A choice of power plant, to all practical purposes, did not exist. Now, electric motors and steam, gasoline or Diesel engines may be had. And a power shovel is no longer just a shovel. By removing a few bolts and re-reeving the lines, it becomes a crane or a dragline. Similar changes have occurred in other equipment. In the old text books and magazines we look in vain for the finished mechanism that is the modern road paver. We do not find the three-speed hoist, the motor roller, the steel material towers or the pneumatic-tired dump trucks. The

tractor of 1920 was more often than not a miniature threshing engine, from which the modern tractor differs so radically that it can hardly be said to be an adaptation from these earlier models. This development has taken place, not in the century that it took the daguerreotype photograph to become a curiosity, but in less than a decade—in construction terms, during the handling of three or four large jobs. It behooves every contractor periodically to compare his equipment with the most modern that is offered. The construction job is no place for the collection of antiques.

Widening Fields

ENGINEERING activities are slowly, but we believe steadily, extending their influence on human and business affairs generally. Many times in recent years we have had occasion to point out evidences of this growth. It finds new reflection and at the same time a more efficient instrument in the joining of technical and business publishing announced in our news columns last week. Not only does the merger speak of the strength which the printed exchanges of the engineering profession have gained but it denotes a recognition on the part of both business and engineering that they need to come into closer contact. Standing as the spokesman of engineering thought, the McGraw-Hill company will now be able to obtain for it a more attentive hearing in the circles of business than it has had in the past; and such hearing is ever more greatly needed as the days pass. There are new responsibilities in the change, but they are a mere restatement of the increasing responsibilities of the profession. The engineer's field is daily widening, and therewith his obligation to widen his own outlook while retaining his definitely objective scrutiny of problems.

Belt-Conveyed Concrete

BELT conveyors have rare mention in the text books as means for transporting concrete. This is perhaps due more to their only occasional employment, until within a year or two, than to the fact that their use is a new thought. Our recollection of belt-conveyed concrete dates back 25 years. Perhaps it is even older. But the fact is true that prior to two years ago it was not commonly employed. The segregation bugbear was one prominent reason. Again it was doubted if any but rather flat grades could be overcome. And most important was the fact that the belt conveyor seemed expensive to buy and use—the cost and difficulty of shifting being perhaps most formidable. It is important to observe, then, in all the recent successful belt-conveyor operations, as the construction of the West Side sewage-works in Chicago recently described in *Engineering News-Record*, how the element of flexibility previously lacking has apparently been supplied in the high mechanical development of portable belt conveyors. Within a few years these self-contained conveyor units have become almost as portable as any equipment on wheels. With their ability to move easily from point to point along a feeder belt line and with automatic traveling trips to give them their load at any point, a belt-conveyor system has as much aptitude in putting concrete where it is wanted as most other devices of commensurate capacity. Inclines as steep as 30 deg. are being traversed by concrete of 5- to 6-in. slump, and under reasonable care in feeding the belt the segregation is not of disturbing magnitude. Altogether the concrete contractor is warranted by the development of the last year or two in placing belt-conveyor carriage of concrete among the capable means at his service.

An Engineering Classic

IN A paper recently presented to the American Society of Civil Engineers, Professors S. M. Woodward and F. A. Nagler have given the profession an engineering classic. Their paper is an analysis of fact so keen and at the same time so fair and judicious in both method and conclusion as to constitute a model of engineering induction. If these qualities give it an exceptional fascination to the inquiring mind, its strength of appeal is further heightened by the subject, which is one of the most perplexing factors surrounding floods and flood protection.

Serious attention to the destructive power of floods and how to guard against them has been long delayed. Little real engineering study was given to the matter until about twenty years ago, and not until the phenomenal rainfall that deluged the belt of country north of the Ohio River in 1913 did flood protection gain a place in the first rank of engineering problems. Even after this period, and in spite of a steady repetition of flood disasters, the public remained apathetic except locally in the wake of great destruction, as at Pueblo. The great flood in the lower Mississippi in 1927 finally translated the problem into such huge proportions as to assure the subject permanent attention.

There are ordinarily long intervals between great floods, and since all American river-flow records are short there is a tendency for higher floods than any on record to make their appearance. Further, land culture and river-bank settlement modify stream flow. Under these conditions of complication, various men have been inclined to single out either one or another factor in the situation as decisive, and develop correspondingly individual theories of flood prevention.

Thus, deforestation was widely blamed as a cause of increased flood height. Others saw the chief source of trouble in the extension of land cultivation and the coincident reduction in soil cover. Soil erosion and flood incidence were correlated by others, who therefore advocated contour plowing. And, finally, land drainage was charged by many with a material contribution to floods. Following the Mississippi Valley flood of last year in particular, drainage was brought into the argument and by implication a distinct share in the destruction wrought in the lower valley was assigned to those progressive agricultural states along the upper and middle course of the river which had developed drainage most largely. It is this question of the influence of drainage upon floods that the paper in question finally places on a basis of definite proof by fact. Unreasonable as the argument of drainage influence was—since the increased soil-reservoir storage resulting from the lowering of groundwater level due to drainage could only operate to retard runoff—it yet was sufficiently persistent and influential to have a seriously confusing effect on proper understanding of the flood problem. By laying the ghost of drainage, Professors Woodward and Nagler thus contribute greatly to the advance of flood study.

The method which they adopted in their analysis is intensely instructive. Briefly, they first studied the records of the development of land drainage in the upper Missis-

sippi Valley, and found two large regions in which drainage has been so far developed as to affect a large fraction of the potential runoff. The beginning of drainage development, however, was considerably later in the more westerly of the two regions, so that substantially the whole development of drainage here occurred within the past twenty years. On two large rivers which drain this region, careful flow observations have been made since before drainage began. Accordingly this region, in central and northern Iowa, was selected for the study.

Prior to 1905, organized drainage work in this region was not very extensive, due to lack of suitable legislative authorization. The great bulk of the work was comprised in the ten-year interval, 1907-17. A four-year record of stream flow, 1903-06, was accordingly taken as representative of flood relations prior to drainage, while the six-year period 1918-23 was taken to represent conditions with drainage. The total contributing areas above the several stream-gaging points range from 3,000 to 14,000 square miles, and the drained fractions range from more than one-third to substantially the whole of the area, for the later period of stream-flow comparison. The case thus selected for study is remarkably well adapted to the purposes of the inquiry; nowhere else in the country could equally favorable conditions for the comparison be found, as the authors well emphasize.

Since rainfall conditions and flood probabilities in the two selected flood-flow periods were in all likelihood quite dissimilar, the investigators made their analysis by studying particular storms and their runoff. Preliminary comparisons of monthly runoff with monthly precipitation during the spring months showed rather widely scattering results, but the scatter areas for the pre-drainage and post-drainage periods coincided fairly well. Next, every storm that produced a flood exceeding a certain minimum was analyzed; again the plotted points showing relation of flood runoff to precipitation fitted closely together for the two periods. Thus the analysis almost incontrovertibly proved that drainage has caused no measurable difference in total runoff. The same thing was found for peak rate of flow, the results again grouping closely enough to furnish a definite test of the question at issue. Thus drainage also has not increased the peak flow of floods.

Though these results afforded conclusive proof, the authors carried their analysis still farther by applying a more delicate test of change in the water-retentive power of the stream basin due to drainage. This test was found in a comparison of the rate of decrease of flow after the flood peak, which decrease would obviously be more rapid for the less retentive condition; that is, if drainage caused the water to discharge into the stream more rapidly, the flood wave should ebb away more rapidly after its peak than it did in the undrained condition of the land. But the comparison showed no difference, and it could only be concluded that the watershed was fully as retentive after drainage as before.

In demonstrating that land drainage has had no detectible effect upon flood flow in rivers, the authors build up their proof from data selected with the utmost care to get a fair comparison, and their analysis utilizes these data with the highest degree of ingenuity and incisiveness. Their findings, as we said above, will be of distinct assistance in fostering sound engineering thought on flood protection. Even beyond its value in this respect, however, their studies will long stand as a classic example of scientific engineering analysis.

Fundamental Work

THERE is a vast amount of investigating and observing that remains to be done in connection with the behavior of engineering materials. Of this fact last week's proceedings of the American Society for Testing Materials gave a particularly clear demonstration, since they brought to light a larger amount of such investigative work, both completed and current, than has been reported at any prior meeting. Study of materials has been going on these many years, yet the farther our technical arts have progressed the more study of materials they call forth. Under modern engineering conditions technical advance is basically dependent on the phenomena of behavior of materials, and the study and measurement of materials therefore is fundamental work.

In the latest reports of investigations we find, for example, one group that occupies itself with measuring the ability of two bearing surfaces to operate in contact without seizing. Another records the power consumption in the mixing of concrete, as an indicator of properties of the resulting mixture. A third group conducts laborious experiments on the relation between corrosion and endurance of steels, and on the effect of corrosion inhibitors on this relation. Each investigation is vital to the practical arts concerned. Such studies as these—and many more of equal importance and novelty might be added—are concerned with questions that had no recognized importance only a few years ago but today are the key to further progress. Chapters of knowledge that seemed closed a generation or a decade ago furnish a bare starting point for present inquiries.

Under the pressure of these developing demands, recent years have witnessed a steady movement forward in the searching out of new knowledge of materials. Within the past year or two there has been a decided quickening of this movement, due to some important contributory factors. On the one hand the manufacturing industries are keenly alive to the value of study. They have been slowly learning the importance not only of research in the higher sense but also of the more routine measurement, inspection and comparison, and today most of them recognize that their efficiency and their power to compete depend on this work. On the other hand industrial associations are entering into study of technical problems. And finally, in the non-commercial field, schools and associated experiment stations have become exceptionally active in research and measurement. Unconscious rivalry among these several agencies further heightens the vigor of their several efforts.

Present indications are for continuing growth of this movement. One incentive arises from standardization and simplification of products, which reveal at every turn the insufficiency of present knowledge and industrial skill as a basis for satisfactory standards. It is therefore natural that the American Society for Testing Materials, chief of our active standardizing bodies, should be a great center for the publication and discussion of investigative problems; and for the same reason its widening field is bound to make this part of its work yet more important. The study of test materials and methods, originally its sole concern but later outranked by the formulation of standards, may yet resume the position of its major activity. But even apart from any single society, the technical and industrial growth of the country is now so closely interwoven with investigation of materials as to make it certain that this field will remain intensely active for a long time to come.

Concrete Bridge Construction on Curve

Cableway Adapted to Handling Materials for Thirteen-Span Bridge on a Sharp Curve at Reading, Pa. —Careful Centering Aided in Balancing Arch Thrusts —Nice Formwork Demanded by Curved Cornice

THE construction last year at Reading, Pa., of a long concrete viaduct on curve called for exceptional nicety in formwork and presented a plant layout problem of interest. Quick completion was also a requirement that gave the contractor a pretty problem in scheduling and co-ordinating construction operations. The contract called for completion in 175 days. As the excavation proceeded, however, foundation conditions were found to be unfavorable and the time limit was extended 45 days. Construction was actually begun on April 1 and completed on Dec. 23, 1927. In this period 12,000 cu.yd. was excavated, 900,000 ft. b.m. of formwork was erected, 418 tons of reinforcing steel was placed and 16,500 cu.yd. of concrete was poured.

Bridge Structure—The new bridge, named the Lindbergh Viaduct, crosses a deep valley owned by the city as park area. Its general direction is east and west on a curve bowing north. Because of future park development, a structure of better appearance than mere utility would demand was designed. This and the curved plan made the chief need for the refinement in formwork and finish, which are considered later. Both general appearance and structural form are indicated by Figs. 1 and 2.

In detail the bridge consists of thirteen open-spandrel, three-rib arches carrying a roadway slab and two outside sidewalks on brackets. At the east end there are two and at the west end there are six arches of 41-ft. 7½-in. clear span. Between these two sets of end arches there are five arches of 83¼-ft. clear span. Adding the pier widths gives a bridge length of 900 ft. on the center line on curve. Where the large and the small arches abut, there are abutment piers as shown by Fig. 4. The other piers are plain rectangular shafts under the ribs for the small arches, and for the large arches they are across-bridge walls of wedge section horizontally so as to give square arches.

Originally the piers for the large arches were designed as solid columns under the ribs and with curtain walls between columns. With the discovery that the foundations would not be to solid rock at 10-ft. depth and must in instances go twice as deep, the design was changed to solid piers. As actually built, as shown by Fig. 3, which also shows the floor slab and arch ribs, the larger of these piers were 56½ ft. long and from 30 to 34 ft. high from footing to springing line. The average thicknesses at these heights were 12 ft. and 10 ft. These high thin pier walls gave the contractor his first particular problem in concreting the arches so as to avoid unequal thrust. The second main construction problem imposed by the design was the curve of the bridge, which required a changing and different sidewalk overhang on both sides and separate forms for every part of the railing and cornice structure. Third, the location and the curved alignment required a special study of plant layout.

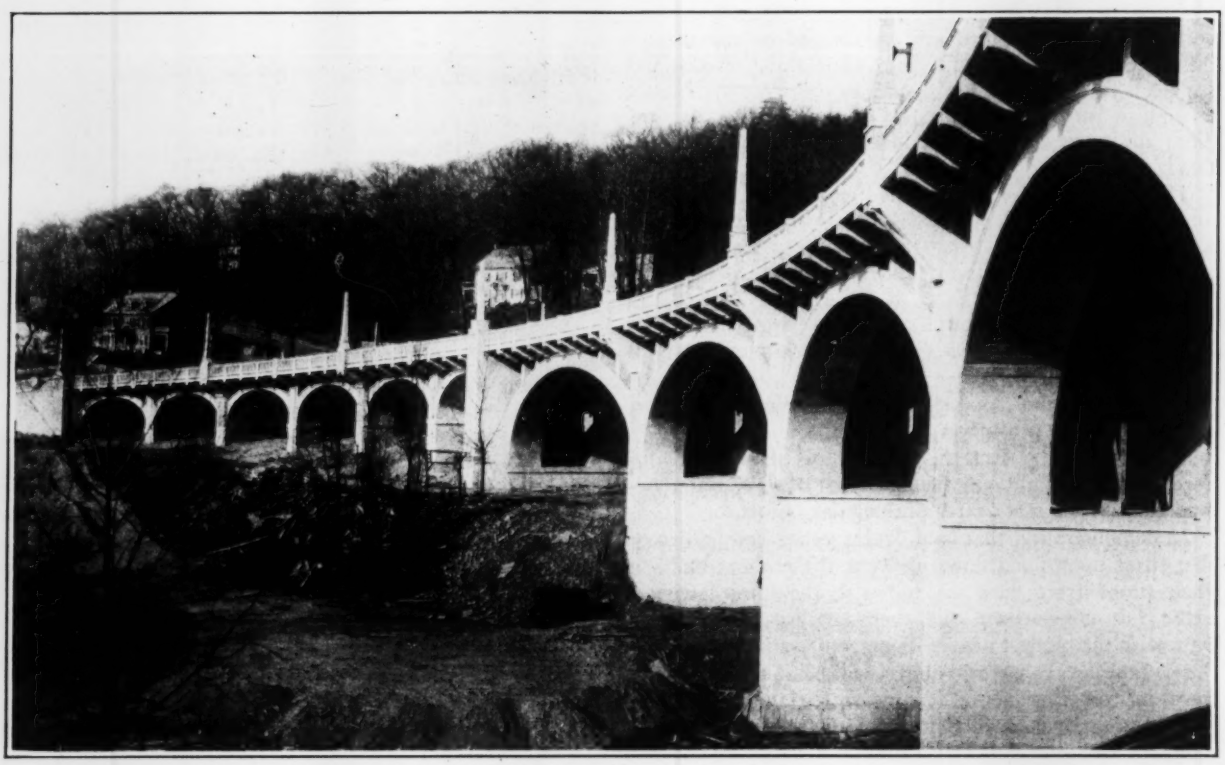


FIG. 1—LINDBERGH VIADUCT, READING, PA., FROM VALLEY FLOOR, LOOKING WEST

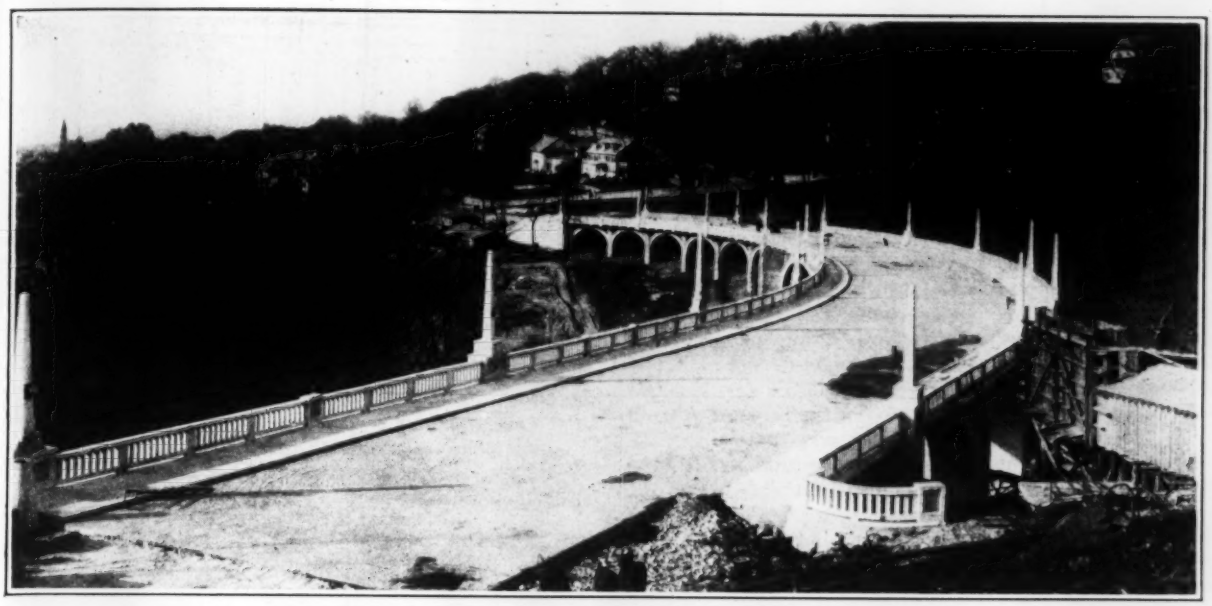


FIG. 2—LINDBERGH VIADUCT FROM ABOVE, SHOWING ROADWAY

Plant Layout—Delivery of material had to be by trucks, and the point of easiest access to the bridge was at the east end. Here the side hill, with its old roadways, made easy the construction of a gravity mixing plant and afforded stock piling room. Another inducement was that this was city property, whereas at the west end a large part of the land north of the bridge was privately owned and the rental charge was high. As the engineers had prohibited long chuting of the concrete, a cableway was the logical equipment for handling materials onto the bridge. This, to cover any considerable length of the bridge arc and also to have a direct pick-up of concrete buckets, required the mixing plant to be north of the bridge. The situation is indicated by Fig. 5, which shows the mixing plant north of the bridge at the east end, with the cableway directly over the mixer, and the minor plant structures, all on city land, at the west end south of the bridge.

The cableway was of standard type and its location, as shown by Fig. 5, was worked out to cover as much of the work as possible by just skirting the inner edge of the bridge curve, to provide a direct vertical pick-up from the mixer and to keep wholly on city land. In fact, to meet this last requirement, the west tower of the cableway was located within the bridge limits, an opening being left in the deck for the tower and afterward filled in when the cableway had finished its work. Direct placing by cableway was possible for only a portion of the span. To supplement it, tower hoppers and chutes were required, and at the ends of the bridge further carriage was provided by short stretches of service railway on trestle. The longer of these railways at the west end is indicated on Fig. 5.

Concreting Operations—The gravity mixing plant was without particular features. The mixer was a 1½-cu.yd. machine and carriage was by 2-cu.yd. bucket, lifting directly from the mixer discharge pit and running to tower hoppers which chuted to forms. Plain volumetric mixes—1 : 3 : 5 below springing line and 1 : 2 : 4 above springing line—were used without any particular

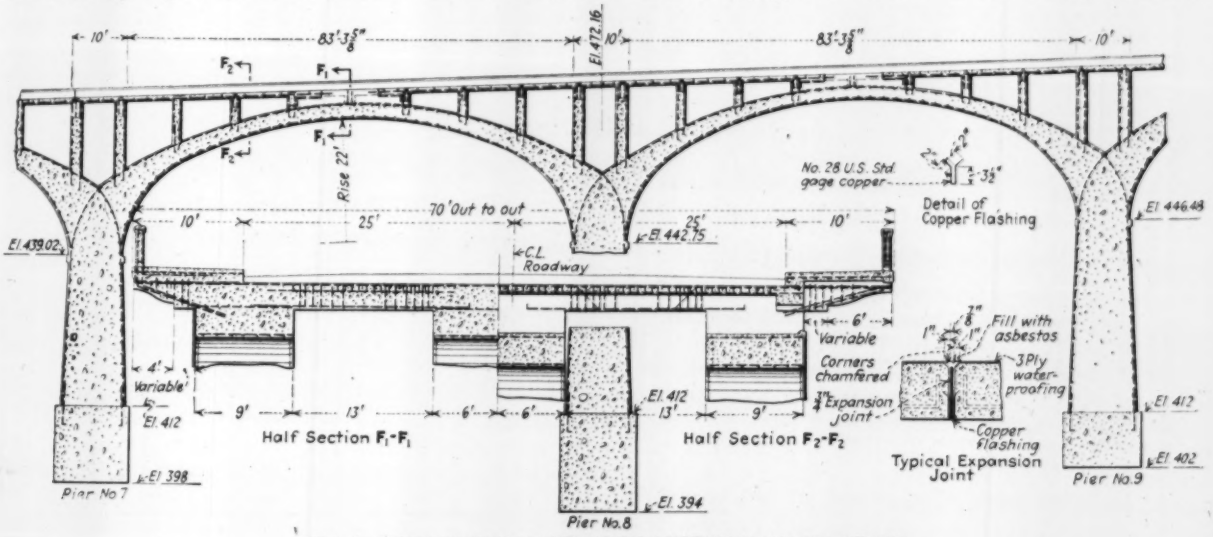


FIG. 3—BRIDGE DECK AND ARCH SECTIONS, 833-FT. SPANS

fussing after designed concrete. The mixes and the concrete were good.

The plan of concreting was to carry on like operations altogether, in so far as it could be done. Thus, for example, all the footings were poured as one operation and all the pier shafts as another operation, and so on. This procedure prevented re-use of forms and required a large amount of form lumber, but it gave speed. The concreting operations ran about in the following order: (1) Concreting the footings, (2) concreting piers to springing line level, (3) concreting umbrella sections of arch ribs, (4) concreting arch ribs and crown bays of roadway slab, except shrinkage sections at haunches, (5) concreting haunch shrinkage sections, (6) concreting spandrel walls and remaining roadway slab, (7) concreting sidewalk, (8) concreting pavement base on deck slab and (9) concreting railings, light standards, etc. Usually concreting in each operation began at the west end.

In general the main problem in concreting was to keep the arch thrust balanced. In pouring the piers, therefore, the operation was continuous, so that no construction joints existed to form possible planes of weakness. For example, the three tallest piers 7, 8 and 9 (Fig. 3), containing respectively 600, 700 and 800 cu.yd., were each poured in a continuous operation of 24 to 36 hours. The plan also was to put in all of the centers for each of the three groups of arches before any arch concrete was poured. First, all of the centers were put in for arches 1 to 6 inclusive, then for arches 7 to 11 inclusive and then for arches 12 and 13. By this arrangement the pier shafts between abutments and abutment piers (Fig. 6) were well braced by the continuous centering against unequal thrust in concreting. Also, by putting up groups of centers at once, speed was gained in pouring, and this gain was considered important enough to balance the cost of using centers generally only once.

The three arch ribs were concreted simultaneously in all but arches 8, 9 and 10. Each rib was concreted in five sections: two haunch sections, a crown section and two shrinkage sections at the skewbacks. Virtually the haunch and crown sections were a single concreting operation where conditions permitted—that is, there was no definite time period between pouring haunches and crown. The shrinkage sections, 4½ ft. long between umbrella ribs and haunch sections, were, however, poured after the other rib concrete had set and shrinkage had taken place.

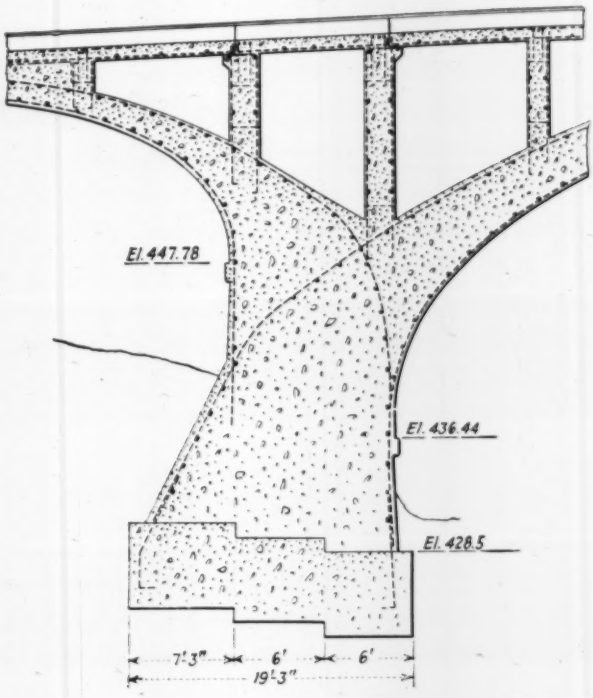


FIG. 4—ABUTMENT PIER AT JUNCTION OF SHORT- AND LONG-SPAN ARCHES

In arches 8, 9 and 10 the arch was concreted half width at a time.

Centers and Forms—All the arches except 8, 9 and 10 were poured on timber centers built the full width of the arch. Steel centers were used for arches 8, 9 and 10 and were half the width of the arch (Fig. 7). When the first half, 1½ ribs, had hardened, the centers were shoved sidewise and the remaining 1½ ribs were poured. To avoid a jog in the center rib soffit, where the second half joined the first, the center in addition to its regular end supports was hung from dowels of steel rods left projecting from the junction face of the half-rib first concreted. This resort was entirely successful in its purpose. It may be repeated that the wedge section of the piers made all centers square. They, there-

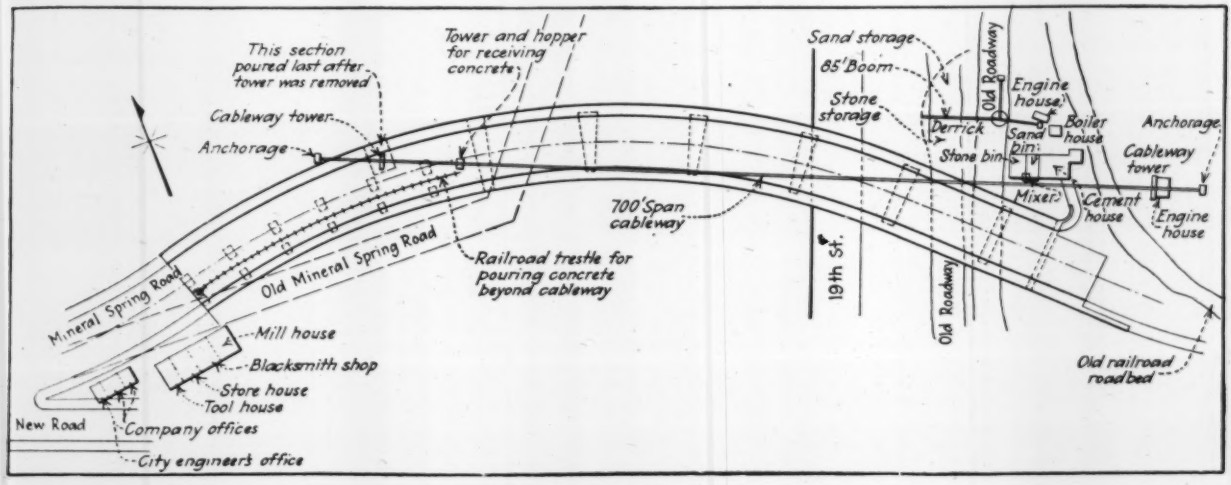


FIG. 5—CONSTRUCTION PLANT LAYOUT FOR CURVED PLAN

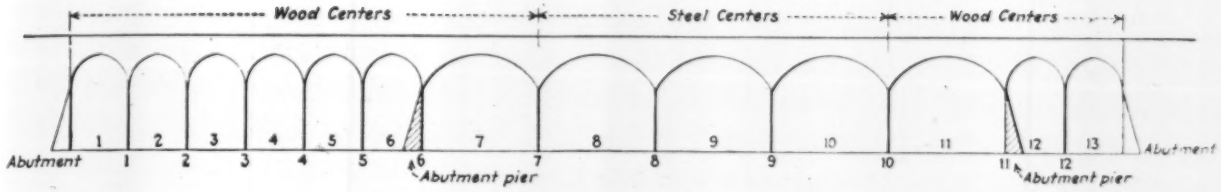


FIG. 6—CHART OF ARCH AND PIER NUMBERS

fore, were of simple construction despite the curve of the bridge.

Indeed, the faces of the arches formed sides of a polygon in the lines of the exterior arcs of the curve, the true arc being obtained in the sidewalk overhang, facia and railing. This called for extreme nicety and formwork—the railings and pylons being cast in place—and also for separately built forms for practically every foot in length of the bridge on both sides. Every length of cornice form was built to true curve, not in a succession of tangents; every sidewalk bracket to a different length radial to the curve. The result, as indicated by Figs. 1 and 2, was an excellent appearance. There also was a very large consumption of form lumber. Including

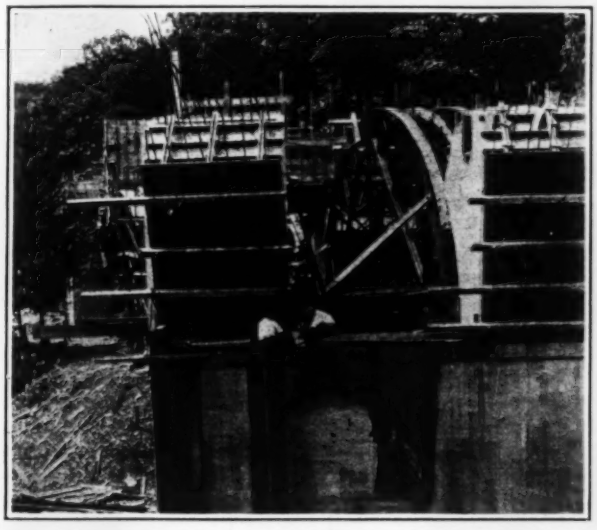


FIG. 7—STEEL CENTERS UNDER HALF-WIDTH OF ARCH

centers and pier forms, more than 900,000 ft. b.m. of lumber was worked up on the bridge.

A careful finish was considered to be a logical concomitant of the precise formwork, and every surface, including the soffits of the arch ribs, was ground smooth with a concrete finishing machine and then rubbed with carborundum brick and cement grout.

Progress and Personnel—Concreting was begun on April 9 and the bridge was finished on Dec. 23, 1927. A total of 16,800 cu.yd. of concrete was poured, at an average rate of 650 cu.yd. each week. For the week ended June 25 and that ended July 2, 1,100 cu.yd. was poured each week. The peak of production was reached when 1,300 cu.yd. was poured in the week ended July 15.

The viaduct was designed by Charles E. Sanders, county engineer of Berks County, Pennsylvania. It was built by the Whittaker & Diehl Company, of Harrisburg, Pa., D. L. Diehl, president, H. S. Thomas, superintendent, and J. E. Minnich, chief engineer. The contract price was $394,347.69, without cement. The cement cost $49,589.92, making the total construction cost $443,937.61.

Endurance and Other Properties of Rail Steel Investigated

The Bureau of Standards has published the results of a co-operative investigation with the Manufacturers Rail Steel Committee and the joint committee on stresses in track of the American Railway Engineering Association and the American Society of Civil Engineers in the study of rail failures, with particular reference to transverse fissure failures. Transverse fissure failures in rails are known to be progressive, or fatigue, failures, developing under repeated track stresses and starting from definite nuclei, the origin of which is not yet known. Knowledge of the endurance properties of steel, it was believed, should throw light on this problem.

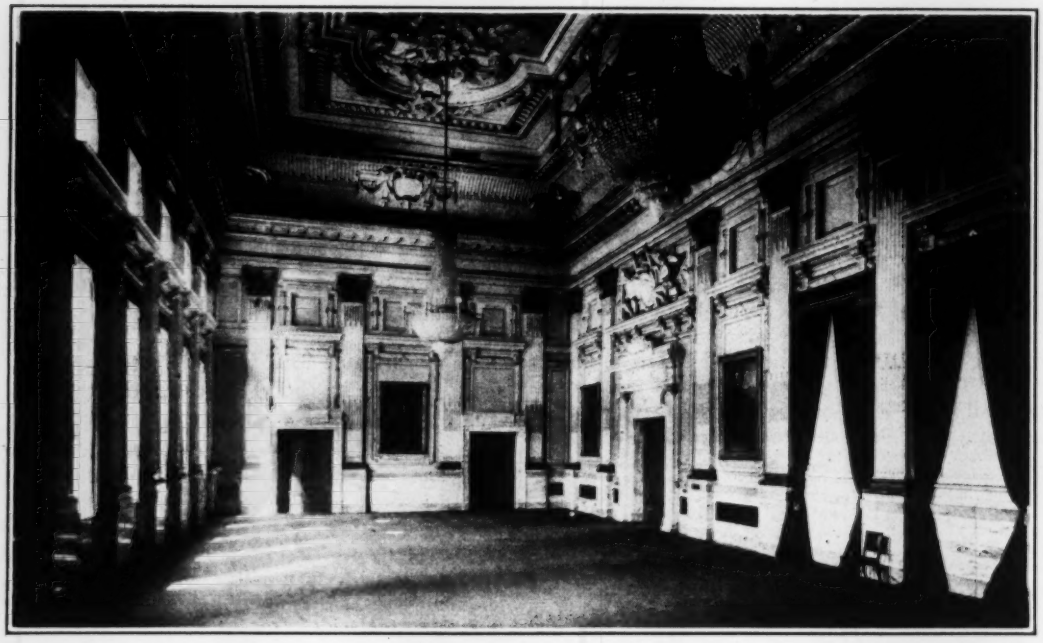
The quantitative endurance properties of rail steel before and after service have not heretofore been determined. Specimens from new 100-lb. rails made by standard methods and also from rails rolled from sink-head ingots have been tested in the usual rotary beam fatigue test. Specimens cut from the head of 100-lb. rails which passed the specification requirements of the American Railway Engineering Association gave endurance limits from about 41,000 to 59,000 lb. per sq.in. "Overstressing" was found to reduce the endurance limit and "understressing" to raise it. An endurance limit of 65,000 lb. per sq.in. was obtained by "understressing." The rail steels from sink-head ingots showed in general greater fatigue strength than specimens cut from the rails rolled from standard ingots.

It should be emphasized that the values for endurance limits given are for the steel in the rail only and do not necessarily apply to the rail in track. A greater knowledge of the stresses in track must be had before these laboratory tests and service data can be correlated.

Plans have been made to redetermine the endurance limits of specimens of rail steel from these same heats, now under observation in service, after they have been removed from track. It may be possible from these tests to determine whether the rail in service is being "understressed" or "overstressed."

Automatic Vents Reduce Tornado Damage

Automatic air vents in buildings will prevent much of the damage resulting from tornadoes, according to a bulletin issued by the Forest Products Laboratory of the U. S. Department of Agriculture. The bulletin states that the sudden lowering of air pressure outside of a building causes an explosive effect which is responsible for the largest part of the damage charged to tornadoes, and that from 10 to 15 per cent of the wall and roof should be vented by swinging windows, automatic sky lights or hinged roof panels to obviate this action.



THE LARGE HALL OF THE INSTITUTION OF CIVIL ENGINEERS, LONDON, ENGLAND
The room is 45x100 ft. in plan and 45 ft. high. The portrait on the end wall is that of Joseph Locke, president of the Institution in 1857. Both of the portraits on the side wall are of Robert Stephenson, president in 1855

Institution of Civil Engineers Centenary

One Hundredth Anniversary of British Society Celebrated With Meetings Lasting Five Days—Visits to Industrial Works and Discussions by International Specialists Are Features

By W. H. Patchell
Consulting Engineer, London, England

THE AUTHOR of this paper, W. H. Patchell, is one of the best-known engineers in Great Britain. For years he has been a consulting engineer in London, and his activities have extended to this side of the water, where he has been retained by several of the large companies in the Edison electrical group. He has been a frequent visitor to this country and is interested in international engineering relations, especially Anglo-American relations. Mr. Patchell is responsible for the introduction in London in 1903 of boilers of new design and with a heating surface of 10,850 sq.ft., nearly double the capacity of any that had been built previously. Mr. Patchell's versatility is indicated by the fact that he is interested in dock construction, colliery equipment, special jigs and dies, welding, agricultural tractors, high-tension transmission, switching equipment and steam nozzles. At the request of *Engineering News-Record* he has outlined the events in connection with the celebration of the centenary. —EDITOR.

THE centenary of the incorporation by royal charter of the Institution of Civil Engineers, June 3 to 7, was celebrated with a dignity becoming the premier engineering society. The inaugural ceremony took place in the Large Hall of the Institution, at Westminster, on Monday, June 4. The delegates joined in sending a birthday message of congratulation to the King on completion of 63 years of a life devoted to the service of the nation and the empire. The message was graciously acknowledged in a telegram which was read out by the president during the banquet on Thursday.

Representatives were present from 96 kindred institutions—in Canada, South Africa, Australia, New Zealand, India, Austria, Chile, Czechoslovakia, Denmark, France, Germany, Holland, Italy, Japan, Norway, Portugal, Sweden and Switzerland, and included the four leading societies in the United States of America and the universities of the empire.

The president, in his opening address, sketched the principal stages in the history of the Institution of Civil Engineers, with its aims, objects and activities. He recalled the founding of the Institution by eight men—James Ashwell, Charles Collinge, Joshua Field, James Jones, John Thomas Lethbridge, Thomas Maudslay, William Maudslay and Henry Robinson Palmer—who may not all have been great engineers but whose names deserve to be remembered for all time, for they laid the foundations not only of this Institution but of daughter institutions in this and other countries. The first meeting took place at a coffee house in Fleet St., on Jan. 2, 1818. Not until 1824 was the meeting place removed to Cannon Row, Westminster. Four years later the Institution obtained its first home in Great George St., where, though in different buildings, it has lived ever since. The first president, Thomas Telford, was elected in 1820 and served fourteen years.

It is remarkable that the words of the 1828 charter which states that the Society was formed for the general advancement of Mechanical Science, and more particularly for promoting the acquisition of that species of knowledge which constituted the profession of a Civil Engineer, being "the art of directing the Great Sources of Power in Nature for the use and convenience of man" have never since been improved upon.

Although the Institution was formed by men who were mainly mechanical engineers, they were soon joined by others engaged in the construction of roads, bridges, canals and docks, who presently seem to have rather submerged their more mechanical brethren and have taken the lead in the conduct of the Institution. Hence the formation of the Institution of Mechanical Engineers, followed by other societies. Although the Institution has always shown a predilection for civil engineering, as it is now generally understood, it is well to remember that it was founded for the advancement of mechanical science.

The delegates of ten representative societies then came forward and read the addresses of congratulation presented by their societies, after which all the other delegates in turn were introduced to the president and presented their addresses, to which Past-President Sir Alexander Kennedy made a very appropriate reply on behalf of the Institution.

James Forrest Lecture

Monday afternoon was marked by the delivery of the 34th James Forrest lecture, by Sir James Alfred Ewing, K.C.B., F.R.S., who took for his subject "A Century of Inventions." The Large Hall was crowded and Sir James kept his audience thrilled. He took as his text a remark of Tredgold's that "the scope and utility of civil engineering will be increased with every discovery in philosophy, and its resources with every invention in mechanical or chemical science." In illustrating this he pointed out that there is another side to the picture, that developments in science are fostered and even initiated by industrial requirements and engineering enterprise and that inventions made for the purpose of serving public need have widened the outlook of science and given it new tools for research. "Nowadays," said he, "theory and practice march together in such close association that it is often difficult to distinguish them as separate figures in the procession."

Sir James observed that if progress were tested by the conquest of inanimate nature, then the century now closing might find no parallel in the past. He likened it to the effloresence of one of those beautiful plants which quietly grow to maturity and suddenly burst into flower. What is left for the future engineer to do? What is to follow? Is the second centenary of the Institution, when celebrated, to show less progress than does the first? Transport, especially by air, may be made less perilous and more convenient. Communication may be extended to include vision; already we can half see. Power will certainly be more generally distributed. But can the engineers of the coming century be expected to bring about developments in the application of natural resources comparable to those of the past hundred years? He doubted it. It seems more likely that there will be something of a lull in the revolutionary fervor of the engineer. The speaker forecast drastic social changes, but not so directly consequent on the activities of the engineer as in the century now ending. Mechanical devices will, of course, be increasingly used, but so standardized will they become as to be taken for granted

Sir James appeared to think that the mental energy of mankind will seek and find outlets in other directions, particularly in ethical progress. We might regret such an issue, but it must be admitted that it might prove beneficial to the human race, since beyond question there is a grave need for progress of quite a different kind. All efforts to apply the sources of power in nature for the use and convenience of man, successful as they were in creating for him new capacities, new comforts, new habits, have left him at bottom much what he was before. As a young teacher the lecturer used to think that the splendid march of discovery and invention, with its penetration of the secrets of nature, its consciousness of power, its absorbing mental interest, its unlimited possibilities of benefit, was in fact accomplishing some betterment of the character of man. But the war came and he realized the moral failure of applied mechanics.

In the diligent cultivation of their arts engineers have possibly forgotten that progress in them has far outstripped the ethical progress of the race. Surely it was for the engineer as much as any man to pray for a spiritual awakening, to strive after such a growth of sanity as will prevent the gross misuse of his good gifts. It is the engineer who in the course of his labors to promote the comfort and convenience of man has put into man's unchecked and careless hands the monstrous potentiality of ruin.

So ended a memorable address in a series of annual lectures which have been given in memory of the long-time secretary of the Institution.

Conference

Under the auspices of a conference committee, 30 short papers had been obtained from specialists in their particular lines introducing various topics for discussion from the many angles embraced in the work of the Institution. Two of the other societies loaned their rooms for the purpose so that several meetings were carried on and papers discussed simultaneously. The arrangement was excellent as a time saver, but it did not solve the difficulty of being in two places and hearing two papers at the same time, which many of the delegates would have been glad to do had it been possible.

The field covered included Recent Developments in Concrete and in the use of Railway Materials, Railway Design and Maintenance as affected by electricity, Steel for Shipbuilding, Marine Propulsion by high-pressure steam and by internal-combustion engines, Utilization of Fuels, solid and liquid, Properties of Materials for use at high temperatures with special reference to boilers, the present Trend in Boiler Practice, Electric Transmission of Power over large areas, Domestic Lighting and Heating, Harbor and Dock Approaches, Harbor Breakwaters, Road and Bridge Construction, latest types of Locomotives, Internal-Combustion Engines, Steam Turbines, Floods, Filtration, Sewage Disposal, and so forth.

The meetings were very well attended, and the discussions kept up in a lively manner, the main difficulty being in affording space for the various speakers to say as much as they wished in the limited time available.

Conversazione and Exhibition

On Tuesday night the beautiful building of the Institution was magnificiently decorated with flowers which formed a charming setting for a conversazione at which the president and council received their delegates and

guests. More than 2,000 people attended. Not only were there concerts, instrumental and vocal, but an entrancing exhibition of engineering models and scientific apparatus had been arranged in the large library of the Institution and in the reading rooms. This embraced models of:

Locomotives from the "Rocket" (1829) to the "Royal Scot" (1928).

The first Cunarder, the "Britannia" (1840) and the post-war flotilla leaders "Keppel" and "Broke."

The Metropolitan Water Board furnished an elm water-main as used in London prior to 1808, the wood of which was well preserved and had been, for show purposes, as highly polished as many a dining table.

The Elder Brethren of Trinity House loaned a model of the old "Goodwin" light vessel (1795) and some of their latest and best reflectors and lenses, showing the progress made through oil lamps with wicks, incandescent gas to gas-filled multiple wire filament lamps.

A model of Maudslay's table engine (1807) and of a gramme dynamo (1870).

A sample of angle rail and stone sleeper-blocks with fastenings used by Outram in the forest of Dean in 1797, upon which vehicles with ordinary wheels were used. Alongside this was a sample of the fish-bellied rail and stone sleeper-blocks with fastenings used in 1816, upon which flanged wheels were used for the first time. For contrast a present standard main-line-type bull-headed rail with cast-iron chairs and fastenings to wooden sleepers, and a latest reinforced-concrete block sleeper with fastenings only tried this year, were on view.

It was possible to compare a sextant used on H.M.S. "Beagle" in 1826 with a modern sextant.

So the past and present were fittingly represented and the progress contrasted in about 100 different exhibits. With all these was a somewhat prophetic display of model transmission line towers for the 132-kw. "Grid" with the proposed outdoor substation, and a model of the proposed "Grid" for Great Britain.

Visits

While the mornings of the days of the week were fully occupied with the discussions of the various papers, the afternoons were devoted to visits to works, which included:

The Fuel Research Station, East Greenwich; General Electric Company's Lamp Works, Hammersmith; Post Office Tube Railway at Paddington, which conveys mails from the Post Office to the main line depots by automatic trains; pumping stations of the Metropolitan Water Board; Overhaul Works of the Underground Railways at Acton; the Deptford West Power Station; W. H. Allen & Company's works at Bedford, where the specialties are pumps, internal-combustion engines, condensers and auxiliary naval sets; engineering laboratories of Cambridge University; Morris Motors works at Cowley; Oxford University, and Port of London.

A trip by special trains to see the reconstructed locomotive works of the London, Midland & Scottish Railway at Crew was a highly interesting feature. These works have been lately reorganized for repairs on a production scale. Sir Robert Hadfield showed us all there was to be seen at his Hecla works in Sheffield. The National Physical Laboratory at Teddington displayed its ordinary run of work, but particularly the result of its recent researches on the behavior of metals under high temperatures. Fraser & Chalmers engineering works at Erith (originally mainly devoted to mining apparatus but due to the change in trade now specializing on steam turbines and internal-combustion engines) has recently turned out the largest oil engine in this country for an electric substation. The reconstruction work at Piccadilly Circus station of the London Underground Railways has to be seen to be believed. The whole of the Circus has quietly, and without ostentation, been undermined, and is now being replaced by a wonderful collection of underground tunnels, approaches, moving stairways and so forth, in connection with this large center for the Underground Railways.

Gas engineers found much to interest them in the works of the Wandsworth, Wimbledon & Epsom Gas Company and road engineers saw the recent road reconstruction works which are being carried out on the East Side of London, which are a fair sample of the way the transport problem is being handled to expedite traffic through London.

Banquet

The celebrations were fittingly concluded on Thursday night with a banquet in the Connaught Rooms, when the delegates were received by the president and sumptuously entertained under conditions which were in no way reminiscent of prohibition. Speeches were numerous. "The Delegates and Other Guests," proposed by Sir Brodie Henderson, was replied to by Alex Dow, president of the American Society of Mechanical Engineers, and three others; "Kindred Institutions," proposed by Sir William Ellis, was responded to by Allen Hazen, of the American Society of Civil Engineers, and three others, so that America was well represented. The selection of the speakers was particularly justified in the representation.

Discussions at the Conference

It is difficult, in such a flood of oratory let loose by leading national and indeed international specialists, to pick out the high places.

In a group of concrete and structural engineering papers the proportion of water to other materials was, as it frequently is, a topic of discussion. It was pointed out that it is a pity that water is so cheap while the other materials used are more expensive. The necessity of alumina cement for road work was questioned, as ordinary portland cement sets quickly enough to keep pace with the workmen.

The universal prodigal use of timber had been made good, for example, by reinforced-concrete piles 110 ft. long, 24 in. square, weighing 28 [long] tons. At the other end of the scale we have a new mixture available for light concrete for roofs and walls made by adding finely divided aluminum powder to the cement, generating oxygen and hydrogen, which, bubbling through the material, causes it to rise, and when set leaves a bulky aerated concrete, which, though very light, is extremely strong.

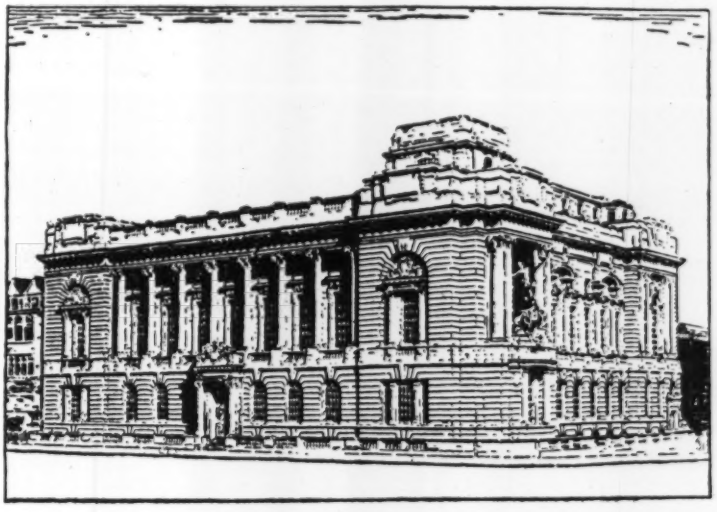
In railway engineering materials, the present utility for railway and bridge work of reinforced concrete was stressed, with a forecast that there would be a considerable extension in the use of such material in the future, particularly when we had better information as to the behavior of such structures under fast running loads. The weight of reinforced concrete and the difficulty in handling it are against the use of the material for sleepers [ties]. Steel sleepers have been much used up to the present but until a pressed steel sleeper with a chair bracket can be made at a cheap price, timber will hold the field.

Rustless steel, which has been mentioned for bridges, is even more important for roofs owing to the high cost of labor for keeping them in repair. Rails have generally a satisfactory life under steam conditions, but they wear out so rapidly on an electric track that there is need for some improvement either in the quality of the steel or the shape of the rail. On electrified lines in Italy, spun reinforced-concrete poles have proved satisfactory. The prolongation of the life of old cast-

iron bridges by strengthening them with reinforced concrete is more interesting for old countries than in the New World. Some of the oldest bridges in Europe have been successfully treated in that way, particularly one of the old Telford bridges in north Wales, which has been widened from 20 to 28 ft. to meet traffic conditions.

The maintenance of an electrified railway track as affected by the design brought out an interesting discussion. Whether the positive conductor rail should be in the 6-ft. way or on the cess side is undecided, as satisfactory instances of the operation of both were quoted.

Is it safer to insulate the tools or to provide the man who uses them with rubber handles and covers for the tools which have to be put on every day and so remind him of possible danger? For voltages higher than 650 it is thought to be safer to have an overhead conductor, because it minimizes the difficulties of track maintenance.



NEW HOME OF THE INSTITUTION OF CIVIL ENGINEERS

The quality of steel used for shipbuilding brought an interesting discussion opened by the president of the Iron and Steel Institute, who said that works are quite ready to supply special steels, but greater care in manufacture is needed, with a corresponding increase in expense. It was suggested that the limit of proportionality should be covered by a guarantee, which brought up an interesting discussion as to the method of taking the limit of proportionality and the too common confusion between the yield point and true elastic limit. It was held that the limit of proportionality is most important when dealing with compressive stresses, as when deformation takes place any eccentric loading is increased. If cold bending has to be done, a low yield point has a definite advantage. It was regretted that although the limit of proportionality was a useful test figure, its determination takes too much time. The carbon content of the steel is important. If it is increased, there is a tendency toward its unequal distribution, which leads to brittleness and segregation. This does not take place with the heat-treated steel, which has the advantage of equal qualities in longitudinal and transverse direction. Therefore it is claimed that heat-treated steel is preferable to a high-carbon steel with a tendency to brittleness. A manufacturer pointed out that the true elastic limit, or the limit of proportionality, was not a proportion of the yield point, and might vary considerably.

The boilermaker still seems to prefer straight steel to alloy steel containing either chrome, nickel or tungsten, as they might present difficulties in handling, but it was stated that in Germany a high carbon and manganese steel is being developed which would be suitable for pressures up to 800 lb.

Very little is said as to the performance of either turbine-driven ships or large motor vessels. It was mentioned that an Italian-owned turbine-driven liner had recently made eight consecutive voyages to South America, whereas two motor liners on the same route had after two round voyages been laid off for repairs. The desirability of using coal instead of oil for marine boilers was emphasized, and was further dealt with in a paper on the "Utilization of Solid and Liquid Fuels" from the British point of view, as it is naturally more important for us than for a country producing natural oil.

The director of the Fuel Research Board gave an excellent résumé on "Solid and Liquid Fuels," discussing the extensive work that the board carries out on both high- and low-temperature carbonization. Possibly more is published regarding low-temperature, although it is responsible for only 25 per cent of the board's expenditure as compared with 50 per cent on the high-temperature carbonization account. The board is trying to find out what coal is and cordially agrees that it is not one substance, but many, which are intricate and interlocked. A better understanding of this is of material assistance in facilitating coal-cleaning processes.

"Coke Oven Town and Producer Gas" was fully discussed and the advisability of co-ordinating gas fuel producers was emphasized. Waterless gasholders have commanded considerable attention during the past hundred years. The outcome is the development of two fundamental principles—the telescopic system and the water seal. Possibly one reason why the waterless gasholder has obtained a better footing in Germany and the United States than in England is because the spiral gasholder does not exist in those two countries, although it is much more economical than the guide-frame holder.

Modern boiler construction was dealt with not only in the high-pressure steam marine versus the internal-combustion marine engine paper but also in two papers regarding the "Properties of Materials Suitable for High Temperatures" and in a paper on "The Modern Trend of Boiler Practice." The paper on "Properties of Materials," which emanated from our National Physical Laboratory, is a very important résumé of the subject, upon which a vast amount of work has been done there. The necessity of co-ordinating research on the subject and so saving both time and money was emphasized. Very complete tests on "creep" take time. Alongside these long-time tests can we not develop some short cuts which would enable us to identify the desired characteristics rapidly? It would probably be necessary to move slowly, as such tests might be misleading, but the need for them is urgent. The opinion was again expressed that the boilermaker at present preferred, and it was safer for him to use, straight steel and avoid

alloys. The present temperature limit of 840 deg. F. was being passed. Designers are now being asked—in fact, an order is already placed—for work which will have to stand at 900 deg. F., with the anticipation that 1,000 deg. F. may be reached. The introduction of the big boiler here 25 years ago was mentioned, and its adoption in Detroit a few years later, culminating in the starting up last year in Detroit of a boiler having 43,000 sq.ft. heating surface. The addition of water walls and heating surface as adjuncts to the boiler was now tending to decrease the size of the boiler proper, although the evaporation per unit was increasing.

Electric power transmission, which will depend so much upon the development of domestic lighting and heating, were both fully discussed. While power transmission systems have been linked up in the United States for commercial considerations, linking is now being considered here as the outcome of an act of Parliament which makes it compulsory. Very closely connected with the growth of the business is the question of tariffs [rates or charges]. Such tariffs must be not only on such a scale as to be commercial for the producer but they must tempt the consumer and satisfy him when caught.

A consideration of Harbors brought up an interesting discussion in which the hope was expressed that the 35-ft. limit of draft might be accepted, except for particular cases, for all ships for the next fifteen years, so that those responsible would know what they had to look forward to. The depth of water at which destructive wave action ceased was suggested as 40 ft., although cases were quoted of solid work in breakwaters having to be commenced at a greater depth than this. The practical limit for diving operations was mentioned as 70 ft., but other speakers considered that 40 ft. was the maximum for satisfactory results.

Foundations for Modern Roads

The foundations required for modern roads was discussed. Concrete foundations 7 in. thick covered with granite setts have not stood the strains of modern traffic, and under similar conditions a 9-in. foundation has shown no trouble. A 30-ft. width of roadway was said to carry 32,000 tons a day without complaint of construction or trouble. The new arterial roads will be more effective when drivers are better educated. Not only does there appear to be bad control and lack of instruction to drivers but speed is largely impeded by the smallest and least important traffic.

The question of internal-combustion versus steam engines again came up from a locomotive engineer's viewpoint. High steam pressure is being used on a simple and easily handled engine of the single expansion uniflow type with poppet valve gear, 300 lb. boiler pressure and 750 deg. F. temperature. Solid-injection Diesel engines are also doing good work in this field. After all, it is not a question of fuel economy. The prime consideration in the selection of an engine is safety and reliability. The question was raised as to whether there was any advantage in giving six or eight exhaust blasts per revolution as against four, when it was stated that on the three-cylinder Royal Scot with six blasts it had not been ascertained what advantage there was from the view of coal consumption, but the effect on the firing was decidedly better than when there were only four blasts.

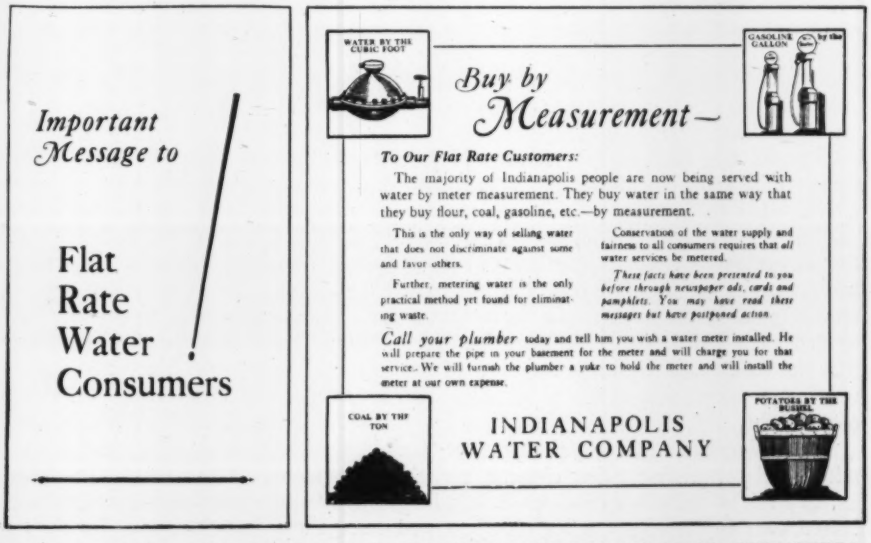
Future Development of the Steam Turbine

In considering the future development of the steam turbine, a plea for fewer steam pressures and standard sizes of turbo-generators was warmly emphasized. Why do we have so many pressures, except to satisfy personal predilections? Thermal efficiencies rise slowly with the rise in pressure. Temperature would help us more. The main point is the necessity of paying more attention to boiler operation.

The design of station plants emphasized the small sizes of units at present common in England as compared with what are likely to be the standard size for the larger stations which would be required under the grouping now being arranged under the Electricity Board. The 160,000 kw., or the 200,000 kw., which we hear of in America, are not on the horizon here.

Direct-to-Water-Consumer Publicity

THE Indianapolis Water Company is making personal appeal to water consumers by means of terse, well-designed and, in some cases, illustrated printed matter. Of two small blotters, one contains a table and cut showing graphically the amount of water wasted through $\frac{1}{2}$- to $\frac{1}{32}$-in. holes. The others refer briefly to the use of water for lawn sprinkling. Supplementary to the latter the company is circulating an illustrated pamphlet, "Making Indianapolis More Beautiful; How to Make and Maintain a Lawn; How to Care for Trees." This is a co-operative production of the department of soils and crops of the Purdue University Agricultural Experiment Station, the Department of Parks, Indianapolis, and others. To promote the use of meters the company is sending out a neat little folder, which is reproduced herewith.


Important Message to
Flat Rate Water Consumers
WATER BY THE CUBIC FOOT
GASOLINE GALLON
Buy by Measurement—
To Our Flat Rate Customers:
The majority of Indianapolis people are now being served with water by meter measurement. They buy water in the same way that they buy flour, coal, gasoline, etc.—by measurement.
This is the only way of selling water that does not discriminate against some and favor others.
Conservation of the water supply and fairness to all consumers requires that all water services be metered.
Further, metering water is the only practical method yet found for eliminating waste.
These facts have been presented to you before through newspaper ads, cards and pamphlets. You may have read these messages but have postponed action.
Call your plumber today and tell him you wish a water meter installed. He will prepare the pipe in your basement for the meter and will charge you for that service. We will furnish the plumber a yoke to hold the meter and will install the meter at our own expense.
COAL BY THE TON
INDIANAPOLIS WATER COMPANY
POTATOES BY THE BUSHEL

INDIANAPOLIS WATER COMPANY FOLDER TO PROMOTE THE USE OF WATER METERS. WHEN CLOSED THE FOLDER IS 3⅜x6-IN.

Removable Steel Stadium for University of Chicago

Seating Capacity Is Doubled Temporarily by Structures Occupying Portions of Athletic Field

By Lester L. Ries

Assistant to Superintendent of Buildings and Grounds, University of Chicago

TO PROVIDE greatly increased seating capacity for its football games, the University of Chicago in 1927 supplemented its two permanent reinforced-concrete stands of 25,000 seating capacity by removable steel stands of 33,100 additional capacity, making the total seating capacity 58,100. The steel stands for the east and south sides of the field have 40 to 50 rows of seats. The latter are shown in Fig. 1, with ramps and ramp platforms. Two separate sections in front of the concrete stands on the other two sides of the field provide 24 and 14 additional rows of seats. As all of these steel stands cover parts of the running track and interfere with the facilities of the athletic grounds, permanent structures in these locations were not permissible. The removable stands are to be erected only for each football season and then taken down and stored.

The steel framing, Figs. 2 and 3, consists essentially of bents having posts, struts and inclined stringers for the deck; the bents are spaced 5 ft. 8 in. c. to c. and are connected by horizontal struts and diagonal bracing. The slope of the deck provides 8 in. rise for each step 25 in. wide. Brackets riveted to the stringers carry the foot and seat planks as shown in Fig. 4. Within the framing of the south stand are longitudinal ramps 8 ft. wide, with grades of 15 per cent, leading to the upper section of the stand. The structure is designed for a live load of 100 lb. on the deck and 150 lb. on the ramps and ramp platforms.

For the post or column footings, concrete blocks 18x18 in., and 30 in. deep, are set 4 in. below a uniform grade in the sodded part of the field and 8 in. below this grade in the running track. A wood block either 4 or 8 in. thick is placed on top of the footing. In each footing is a $\frac{5}{8}$-in. anchor bolt projecting $1\frac{1}{4}$ in. and having a 3-in. sleeve nut. When the post is erected, a machine bolt $2\frac{3}{4}$ in. or $6\frac{3}{4}$ in. long is put through the shoe into the sleeve nut. When the stand is taken down, the wood blocks are removed, the sleeve nuts are filled with heavy grease and the sod or cinder track is replaced over the footings.

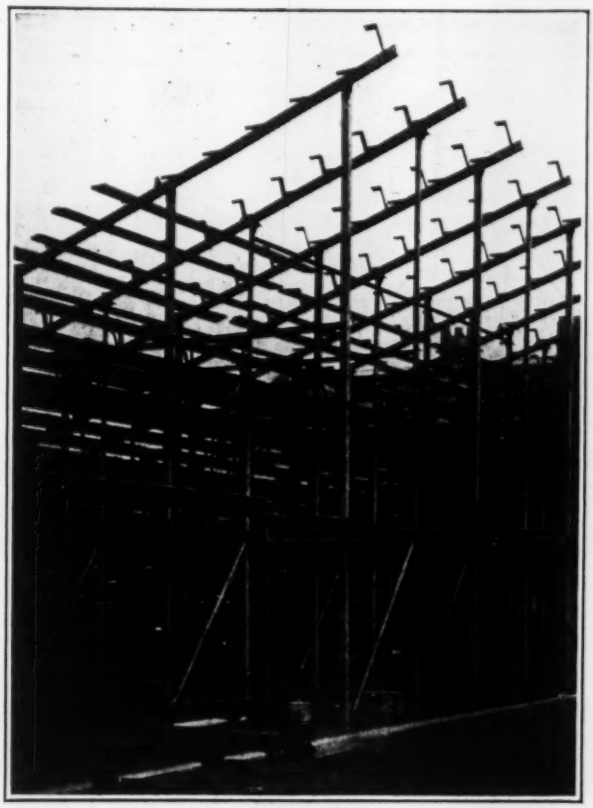


FIG. 2—FRAMING OF STADIUM UNDER ERECTION
All connections bolted to permit of structure being taken down and re-erected.

The posts are $3\frac{1}{2}$x$3\frac{1}{2}$x$\frac{1}{4}$-in. angles, with horizontal struts of 3x3x$\frac{1}{4}$-in. angles. Diagonal braces in general are of single $1\frac{1}{2}$x$1\frac{1}{2}$x$\frac{1}{4}$-in. angles, having each end flattened and punched for two $\frac{5}{8}$-in. bolts. Posts up to 17 ft. high are in single lengths, but higher posts are spliced. The inclined deck stringers are 5-in. channels, with long plate splices, and each is secured to the top of the post by two $\frac{3}{4}$-in. bolts through clip angles riveted to the channel and the post. At its lower end the stringer is anchored by four bolts in a long concrete footing

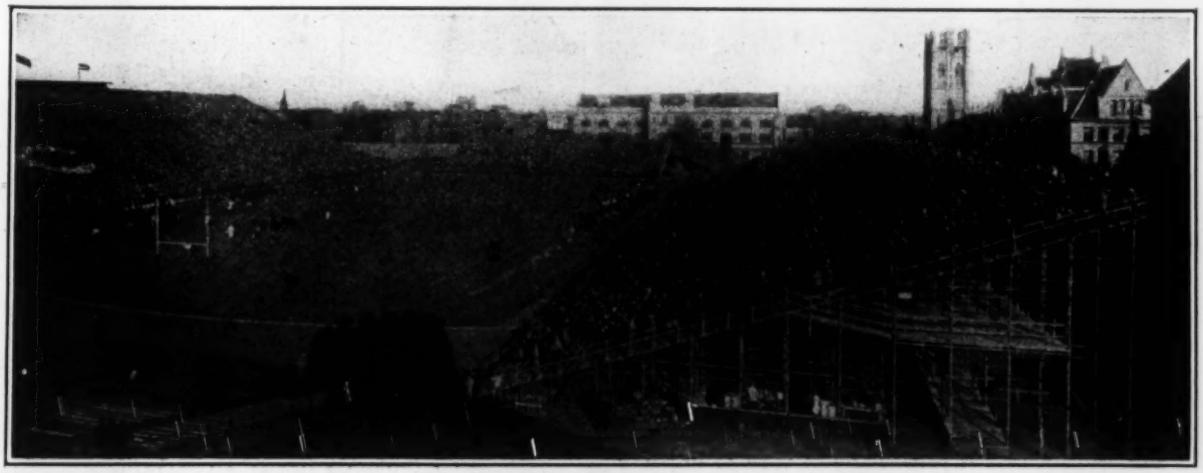


FIG. 1—STEEL STADIUM, UNIVERSITY OF CHICAGO

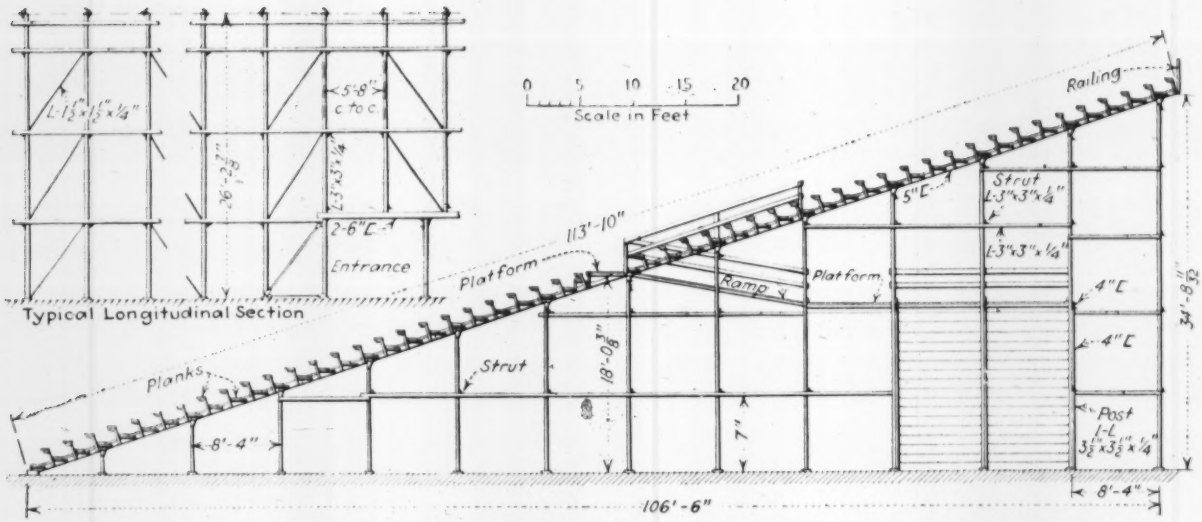


FIG. 3—TYPICAL BENT OF REMOVABLE STADIUM

block which extends back to the next post. All parts are put together with $\frac{5}{8}$-in. bolts, except for the $\frac{3}{4}$-in. bolts in the stringer connections.

Clamps, Fig. 4, hold the seat and foot planks to the steel work. To prevent excessive deflection and play, the planks have interlocking splice plates bolted to the underside, also shown in Fig. 4. On the ramps the $2\frac{5}{8}$-in. planks are secured by steel clips at the ends and by U-clips at the middle to limit deflection. These planks were left rough dressed, to afford good foothold, but the $1\frac{5}{8}$-in. floor and seat planks are dressed smooth and given two coats of paint. To make the curved seats

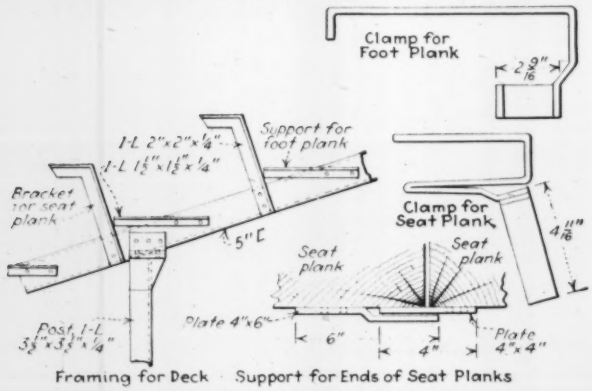


FIG. 4—DECK DETAILS

at the corners, the 10-in. planks were marked with the required radius and sawed along this line, the front segment being then placed at the back and the two parts spliced to form a 10-in. curved plank. In this fabrication and painting of the planks, which was done by the construction force of the university, electrically operated tools were used, the great number of identical parts enabling this work to be done at low cost.

Testing the design for longitudinal rigidity by means of a quarter-size model four bays long was a feature of particular interest. In the original design no diagonal bracing was provided and the posts were to be set on 3x14-in. planks laid on the ground. This loose foundation and the absence of sway bracing were not approved as adequate for safety, particularly in view of ordinary wind forces as well as stresses due to the movements of an excited crowd. To demonstrate these points the model was loaded with pig iron on its inclined deck to represent the weight of spectators, as shown in Fig. 5, and it was found possible for one man to sway the entire structure with its deck load of 8,600 lb. After adding sway bracing and column anchorage the model was found to be practically rigid, even when subjected to severe horizontal loads applied simultaneously to the tops of 44 of the 52 columns. The horizontal loads were applied by means of weights on cords passing over pulleys in a loading frame and attached to the columns.

Loading was applied in increments of 50 lb. up to a total of 200 lb. on each group of four columns. These loads were equivalent to loads sixteen times as great on the actual stands. Thus a 100-lb. test load produced a horizontal pull of 25 lb. at the top of each of four columns, equivalent to 400 lb. at the top of each column in the full-size structure. Since each such latter column supports 47 sq.ft. of deck, this pull would be equivalent to a horizontal force of $8\frac{1}{2}$ lb. per sq.ft. of deck.

As a result of the tests, diagonal braces were applied in alternate bays, the braces being in opposite directions, as shown by Fig. 3. This arrangement was adequate, and was convenient, since the structural work already fabricated did not permit of introducing double diagonal

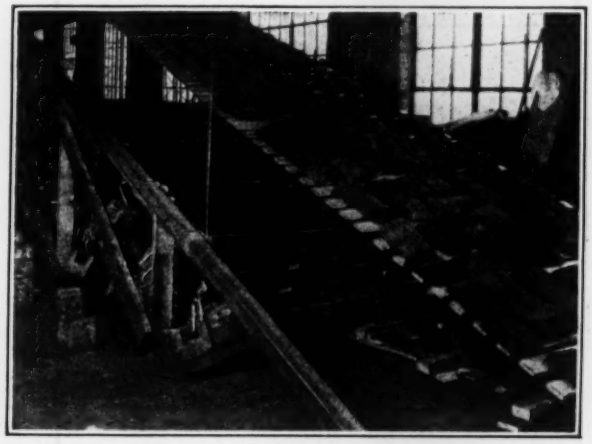


FIG. 5—TESTING MODEL OF STADIUM
Weights attached to cords exert horizontal pull on columns.

cross-bracing. Measurements taken at the stands under full load of a moving crowd indicated longitudinal movements not exceeding $\frac{1}{32}$ in. in the bents, which agreed closely with the figure estimated from the tests on the model.

A total of 485 tons of structural steel was required, with about 40,000 bolts to be placed and removed each time the stands are used. All steel was given two coats of paint. The planking amounts to 290,000 ft.b.m. This structure cost, complete and erected, $6.50 for each 18-in. length of seat. Its removal cost is somewhat less than 18c. per seat and erection is estimated at 25c., as compared with the previous rental of temporary circus-type wooden stands at an average of $1 per seat per year.

This structure was designed by the Portable Stadium Company, New York, but was modified in details according to the recommendations of Condron & Post, Chicago, consulting engineers for the university, who also directed the tests herein described. The steel framing was fabricated by the Calumet Structural Iron Works, and was erected by the Kenwood Erection Company, on the concrete footings put in by the Edward L. Scheidenhelm Company, all of Chicago. The work was done under the direction of L. R. Flook, superintendent of construction for the University of Chicago, with the writer in charge of erection.

Vancouver Considering Harbor Improvements

Plans which would give Vancouver, B. C., a tideless fresh-water harbor and at the same time reduce the heavy currents now encountered by shipping in entering the harbor have been drawn up by W. G. Swan, consulting engineer, for the Vancouver Harbor Commission.

The project involves a dam across Second Narrows, including a reversing spillway 100 ft. wide; a causeway, and two locks, one for deep-sea vessels and one for light harbor traffic. Bascule bridges across the entrances to the locks would permit vehicular traffic over the causeway, which would replace the present bridge. It is estimated that construction could be completed in three years at a cost of $5,000,000.

Welding a Large Gasholder

Tank With Capacity of 300,000 Cu.Ft. Said to Be the Second Ever Built Entirely by This Method

A LOW-PRESSURE gasholder 74 ft. in diameter and 113 ft. 7 in. high above the foundation with all lifts elevated, has recently been erected by arc welding for the Albion Gas Light Company, Albion, Mich. Its weight is about 258 tons, exclusive of about 4 tons of metal used for welding rod. The capacity is 300,000 cu.ft. of gas at a water pressure of 12 in. A single-lift gasholder of arc-welded steel construction, with 15,000-cu.ft. capacity, was built in 1924 for the Missouri Gas & Electric Company, Lexington, Mo., and these two are said to be the only low-pressure gasholders in the United States built entirely by arc welding. The new one at Albion is shown in Fig. 3.

Previous welding work on gasholders led to its exclusive use in this case, since welded joints had proved satisfactory in structural strength and in gas and water tightness. The welding was also claimed to have simplified construction and reduced the fabricating cost. The only shop work necessary was to lay out and punch the members for erection bolts. In the field, plates rolled to the proper radii at the shop were assembled with bolts and tack welded, except that the cups and grips, which were fabricated in the shop, were assembled in sections on the ground and then welded in place.

In beginning the work, the bottom plates were first assembled and welded together on the foundation. When the bottom and first course had been built, they were water tested, but no leaks were found. Figs. 1 and 2 show the work in progress. Lap joints were used. Plating was $\frac{7}{16}$ to $\frac{1}{4}$ in. thick for the water tank, and No. 12 gage for the three lifts. The guide frames were entirely arc welded, as were the goosenecks around the top of each lift. For placing the crown of the upper lift, wooden falsework was built inside. Upon this the plates were laid in circular rows from the out-

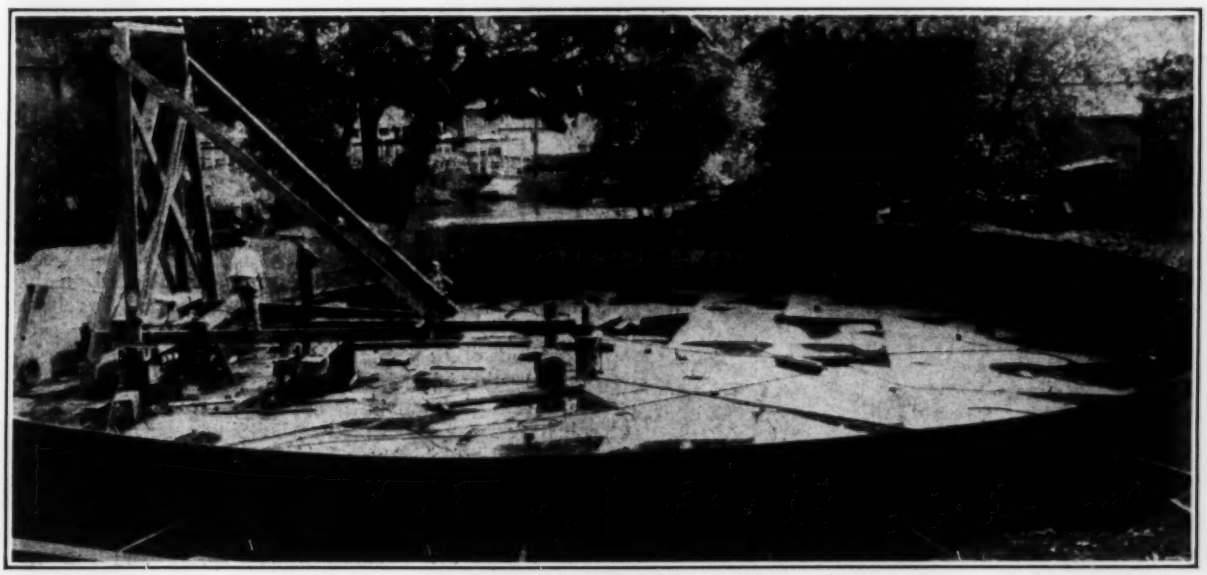


FIG. 1—ERECTING RIG FOR GASHOLDER
The frames against the shell at the right and the far side are the cups mentioned in the article.

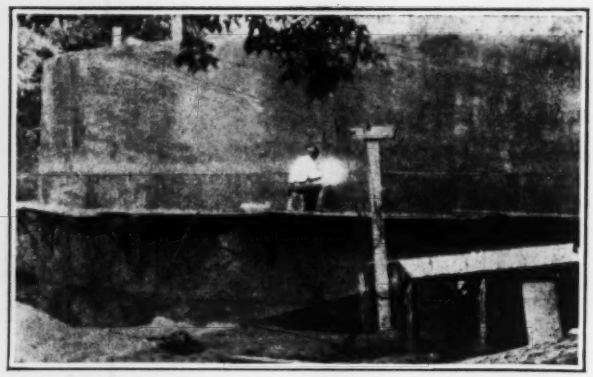


FIG. 2—WELDING A SEAM

side to the center, each succeeding course being lapped over the preceding one, and the plates being tack welded to hold them in position until the crown was ready for the finishing welds. For the 21,414 lin.ft. of welding about 4 tons of welding rod was used by the four carbon-arc welders.

This large welded gasholder was built largely through the co-operation of D. F. Burritt, vice-president in charge of engineering, Middle West Utilities Company, Chicago, and Roy Campbell, president of the Albion Gas Light Company. It was designed and built by the Western Gas Construction Company, Fort Wayne, Ind., under the direction of F. H. Beebe, vice-president, and Thomas W. Stone, chief engineer, the former furnishing information for this description. This company also built the smaller welded gasholder in Lexington, Mo.

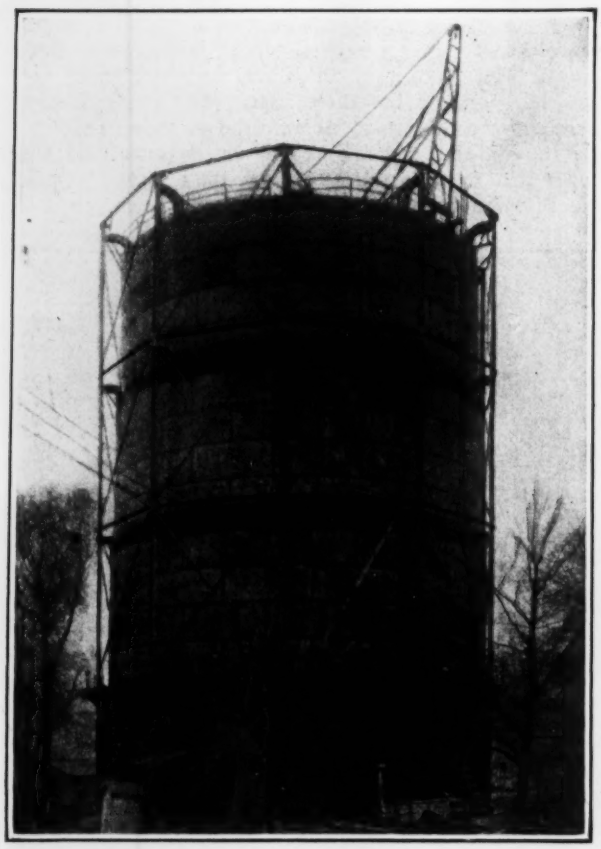


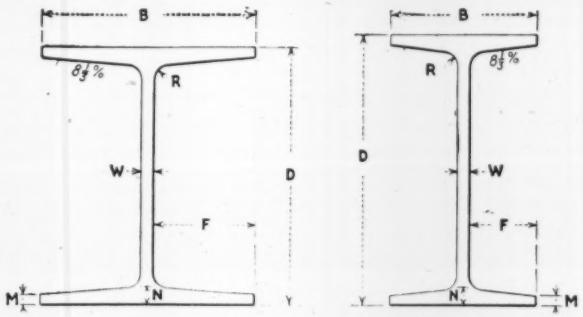
FIG. 3—WELDED GASHOLDER OF 300,000-CU.FT. CAPACITY

Elements of the New 33-In. Rolled Structural Sections

Deepest Yet Rolled Here and Designed to Give Maximum Strength Per Pound of Metal

THE 33-in. beams and girders recently added to its line of wide-flanged structural shapes by the Bethlehem Steel Company are the deepest sections that have yet been rolled in the United States. The beams are available in four weights, ranging from 125 to 152 lb. per foot, and with section moduli respectively of from 394.3 to 478.4. The girders are being rolled in four weights, of from 202 to 230 lb. per foot, and with section moduli respectively of from 676.0 to 778.0. The table gives the complete list of dimensions and properties.

These sections are designed to afford the maximum strength per pound of metal. They have the same con-



BETHLEHEM WIDE-FLANGE STRUCTURAL SHAPES 33-IN. GIRDERS AND BEAMS

Dimensions

Section No.	Weight Per Foot, Lb.	Nominal Depth, In.	Dimensions in Inches: Nominal D	B	W	M	N	F	R
G-33	230.0	33½	33.25	15.810	0.795	1.047	1.673	7.508	0.90
	220.0	33¼	33.12	15.780	0.765	0.982	1.608	7.508	0.90
	210.0	33	33.00	15.750	0.735	0.922	1.548	7.508	0.90
	202.0	32⅞	32.88	15.735	0.720	0.862	1.488	7.508	0.90
B-33	152.0	33½	33.25	11.320	0.650	0.843	1.287	5.335	0.70
	143.0	33⅜	33.12	11.285	0.615	0.778	1.222	5.335	0.70
	135.0	33	33.00	11.250	0.580	0.718	1.162	5.335	0.70
	125.0	32⅞	32.88	11.210	0.540	0.658	1.102	5.335	0.70

Properties

Section No.	Nominal Depth, In.	Weight Per Foot, Lb.	Area, Sq.In.	Thickness of Web, In.	Width of Flange, In.	Maximum Safe Shear, Lb.	For Major Axis: Moment of Inertia I	Radius of Gyration r	Section Modulus S
G-33	33½	230.0	67.85	0.795	15.810	242,500	12,935	13.81	778.0
	33¼	220.0	64.80	0.765	15.780	226,600	12,278	13.77	741.4
	33	210.0	61.91	0.735	15.750	211,000	11,671	13.73	707.3
	32⅞	202.0	59.53	0.720	15.735	202,900	11,114	13.66	676.0
B-33	33½	152.0	44.69	0.650	11.320	167,500	7,953.4	13.34	478.4
	33⅜	143.0	42.05	0.615	11.285	150,300	7,442.2	13.30	449.4
	33	135.0	39.55	0.580	11.250	133,700	6,967.4	13.27	422.3
	32⅞	125.0	36.88	0.540	11.210	115,500	6,482.7	13.26	394.3

tour as other Bethlehem sections, and are rolled on the company's patented Grey Mills. A catalog has been prepared, containing descriptive matter and giving safe loads and other engineering data. According to the company there has been a growing demand for deeper beams and girders, and it is believed these new sections will have large application in building construction, and in railroad and highway bridges. For long spans they are claimed to show considerable economy over any other sections now produced, and it is reported that some state highway departments are specifying these sections for bridges that are included in the spring and summer programs. Regular rolling schedules of these sections are being maintained.

Industrial Growth and New Capital

Investment for New Construction Doubled in Five Years—How the Additional Capital Is Distributed Among the Principal Industries—Figures Show Rapid Increase With Changing Trends

By R. M. Davis

Statistical Editor, McGraw-Hill Publishing Company, Inc., New York City

TODAY the American nation is spending each year for new construction five times as much as it did fifteen years ago. This tremendous increase is a measure of our rapid industrial expansion. Elements of the growth are the enlargement and rebuilding of manufacturing plants, the evolution of power facilities, the construction of a great network of improved highways, the increase in housing due to the drift of population toward the cities, and the more recently developed trend toward modernization in the entire building field, including the commercial as well as the residential class. In less than two decades, the American social, civic, business and industrial life has undergone a radical change and has come to require tools and facilities of far higher type than that of the pre-war age. Modern life would find it difficult to get along with the material facilities of fifteen years ago, hence we incur ever-increasing expenditures for buildings, power plants, railways and highways to meet the changing demands of the times.

New capital means construction investment, as the engineer will readily understand. Its expenditure makes the industrial and business growth of the nation possible. In 1927 the total expenditures for construction in the United States reached eight billion dollars. The traceable amount of new capital issues was close to seven billions. During the past seven years state and municipal construction and public-utility construction were the leading consumers of new capital. The utilities today consume about one-tenth more new capital than do the states and municipalities. Six years ago the consumption was reversed, the municipalities then investing about 50 per cent more in construction than the utilities.

How are these construction investments distributed among the different industries? Have the demands of all industries increased, or have some been growing more rapidly while others were slowing up in rate of growth? These questions can be answered by a study of the records of new financing. The figures for the last six years and the estimated total for the current year (based on the first five months) are grouped in the accompanying tables and graphical plots to show how the different industrial groups compare.

New capital means construction investment, as the engineer will readily understand. Money raised by security issues in the financial market, whether for corporations, for states or for municipalities, is not used to pay wages but is applied to the construction of new plant and to the purchase of new equipment.

In 1913 the total expenditures for general construction throughout the country were $1,600,000,000, while during 1927 they amounted to slightly more than $8,000,000,000. To raise these ever larger sums of construction money, it has been necessary for states, municipalities, manufacturing concerns and private citizens to go into the money markets of the nation and borrow money, giving as security a mortgage on the structure to be built with the borrowed money.

By far the largest part of this financing has been done through the great financial houses scattered throughout the country, and a record of their financial transactions is available and has been summarized in the accompanying tables. They include issues of bonds and of common and preferred stock, but of the total a certain part goes to replace previous borrowing, as when an issue of bonds is sold to retire a previous issue which carried a higher rate or reached its maturity date. The amount of such refunding issues is known and has been deducted in compiling Table I, which thus represents solely those securities which were issued for the purpose of raising new capital.

Besides the construction money raised in this way, there are hundreds of millions of dollars borrowed by individuals through banks, trust companies, building loan associations and private money lenders. These amounts are not included in the tabulated figures. It is to be remembered, therefore, that in addition to the new capital represented by the tables and diagrams there is a further amount, which is indeterminate, yet important in its total. But as this additional amount lies mainly in the class of residential building, which is not included among the groups covered by the tables, the tabulated figures and the plotted curves are essentially unaffected. The total curve would be raised to a still higher position, and perhaps to a still steeper slope, if the private borrowings were included.

In nearly every group the new capital has been increasing year by year; only railroads show a decreasing trend. However, if the 1928 total can be estimated fairly from five months' figures, it appears that for the first time in many years the total security sales will show a decrease from the previous year, apparently due to the lessened capital demand of public utilities, which promises to be $400,000,000 less in 1928 than it was in the previous year.

Capital borrowings represent the money required for the construction of buildings, railways, highways, power plants or sewer systems. It is their expenditure alone that makes the industrial and business growth of the nation possible. "New capital" is in every sense active, and makes its influence felt to the extreme outer ends of the nation's industrial structure.

The true volume of this borrowing is not correctly measured by face value but among other things on the construction price level—that is, on the amount of construction that a dollar will accomplish, and this varies from time to time. Since 1913 the cost of constructing

TABLE I—NEW CAPITAL SECURITY SALES
(Thousands of dollars)
(Includes stock and bond issues, less refunding issues)

	1922	1923	1924	1925	1926	1927	1928
Railroads	$523,807	$464,516	$779,617	$380,281	$345,991	$505,666	$344,000
Public utilities	726,241	887,991	1,325,601	1,495,098	1,604,385	2,074,474	1,620,000
Iron, steel, coal, copper, etc	184,870	291,899	197,871	133,082	193,247	100,471	220,000
Equipment manufacturing	10,156	13,805	19,016	13,766	17,788	23,815	25,000
Motors and accessories	48,360	66,796	29,507	185,145	131,373	94,659	12,000
Other industrial and manufacturing	239,657	324,259	261,425	501,449	526,926	704,886	820,000
Oil	151,105	194,779	167,127	168,357	262,688	317,004	443,000
Land, buildings, etc	161,889	250,911	333,401	715,484	709,467	630,384	750,000
Rubber	19,762	1,685	2,000	64,750	43,214	12,702	15,000
Shipping	20,525	3,568	13,800	30,104	21,450	26,291	25,000
Miscellaneous	249,359	202,285	192,931	411,205	500,472	882,856	750,000
State and municipal	1,070,901	1,043,117	1,379,638	1,352,093	1,343,541	1,436,390	1,500,000
Total	$3,405,635	$3,745,613	$4,701,934	$5,451,818	$5,700,544	$6,809,600	$6,524,000

a given project has increased by about 106 per cent, and even since 1922 there has been a large increase in the amount of money required to accomplish a given total of physical work. The purchasing power of a construction dollar, in other words, is still relatively low. Accordingly, the figures given in Table I are not directly comparable as between different years, and do not correctly represent *relative construction volumes*, until they are reduced to the same terms of physical value. This has been done in calculating the figures of Table II, obtained from those of Table I by dividing each year's figures by the construction-cost index ratio to 1922, thus reducing all the figures to a 1922 base. While the actual amount of new capital issues in 1927 was about $6,800,000,000, it is only sufficient to build projects whose 1922 cost would have been $5,760,000,000. The physical expansion of industry, then, is more correctly shown by the data of Table II.

Another comparison of the figures is given by Table III, which lists the percentages of the year's total for the different construction groups. This table is independent of construction-cost index, and in fact does not depend on whether industry as a whole has been growing or declining; it does show, however, which industry has been gaining over the others, and which has been losing.

Graphical plots of Tables I to III are shown in Figs. 1 to 3. Both Figs. 1 and 2 show clearly the enormous increase in construction investment during the seven years—the total annual investment has been almost doubled in that period and the physical volume of construction has increased 60 per cent. State and municipal construction, and public-utility construction, were the leading consumers of new capital, in physical value as well as in money. They progressed much more rapidly than manufacturing in general, which means much faster than our general industrial growth. On the other hand, railroads tended downward and the mining and metal-producing industries barely held their own. The decline of new railroad construction is particularly clear in Fig. 2.

It is to be remarked in connection with these curves that economic and technical advances sometimes affect the new capital requirements. The trend during recent years toward large combinations of industrial corpora-

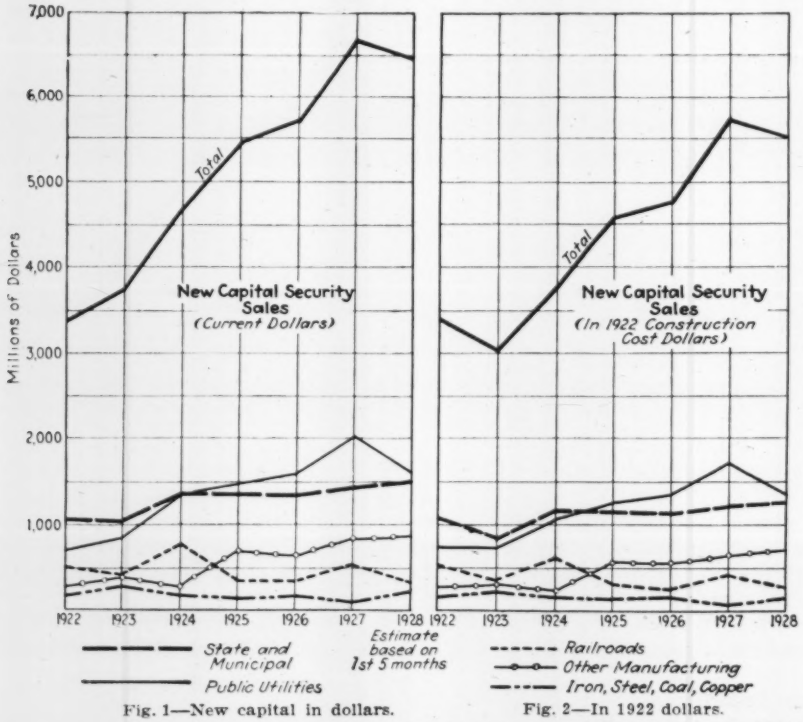


Fig. 1—New capital in dollars.

Fig. 2—In 1922 dollars.

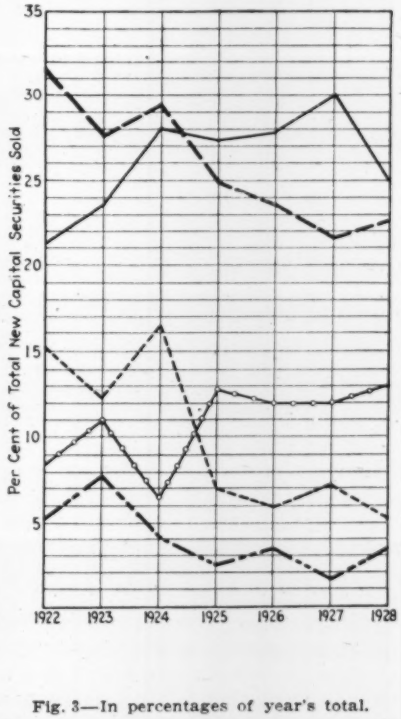


Fig. 3—In percentages of year's total.

CURVES OF NEW CAPITAL ISSUES IN THE UNITED STATES, 1922-28

The plotted figures include issues of stocks and bonds, excluding refunding bonds. They do not include building loan association investments nor private mortgages. The total therefore does not include the major part of residential building. Bond issues for the construction of large commercial buildings, given separately in the tables, are not plotted separately, to avoid too many curves.

TABLE II—NEW CAPITAL SECURITY SALES
(Corrected to 1922 construction prices)
(Includes stock and bond issues, less refunding issues)

	1922	1923	1924	1925	1926	1927	1928
Railroads	$523,807	$378,000	$631,000	$321,000	$289,000	$427,000	$292,000
Public utilities	726,241	725,000	1,072,000	1,261,000	1,345,000	1,750,000	1,370,000
Iron, steel, coal, copper	184,870	237,500	159,500	112,300	162,000	85,000	186,500
Equipment manufacturing	10,156	11,260	15,400	11,600	14,800	20,000	21,200
Motor and accessories	48,360	54,500	23,900	157,000	110,000	80,000	10,300
Other industrial manufacturing	239,657	264,000	211,500	422,200	441,000	595,000	697,000
Oil	151,105	158,100	135,200	142,000	220,000	268,000	379,000
Commercial buildings	161,889	204,400	270,000	605,000	595,000	533,000	637,000
Rubber	19,762	1,370	1,620	54,600	36,000	10,700	12,700
Shipping	20,525	2,910	11,200	25,400	17,600	22,200	21,200
Miscellaneous	249,359	164,600	156,100	347,000	419,000	745,000	635,000
State and municipal	1,070,901	850,000	1,116,000	1,140,000	1,123,000	1,216,000	1,270,000
Total	$3,405,635	$3,060,000	$3,810,000	$4,600,000	$4,780,000	$5,760,000	$5,530,000

TABLE III—PER CENT OF TOTAL NEW CAPITAL SECURITY SALES
(Includes stock and bond issues, less refunding issues)

	1922	1923	1924	1925	1926	1927	1928
Railroads	15.3	12.4	16.4	7.0	6.1	7.3	5.3
Public utilities	21.3	23.7	28.2	27.4	28.1	30.0	24.8
Iron, steel, coal, copper	5.4	7.8	4.2	2.4	3.4	1.5	3.3
Equipment	0.3	0.4	0.4	0.2	0.3	0.3	0.4
Motors and accessories	1.4	1.8	0.6	3.4	2.3	1.4	0.1
Other industrial manufacturing	7.0	8.7	5.5	9.2	9.2	10.3	12.6
Oil	4.4	5.2	3.6	3.1	4.6	4.7	6.8
Land and buildings	4.8	6.7	7.1	13.1	12.4	9.3	11.5
Rubber	0.6	0.1	0.1	1.2	0.8	0.2	0.2
Shipping	0.6	0.1	0.3	0.5	0.4	0.4	0.8
Miscellaneous	7.3	5.4	4.1	7.5	8.8	12.9	11.5
State and municipal	31.6	27.7	29.5	25.0	23.6	21.7	22.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

tions has resulted in the elimination of many factors which tended to limit the value of a certain project and hence to require more capital to attain a certain result. For instance, in the electric light and power field the trend toward interconnection and toward reduction of production costs by larger units, by elimination of small plants and by reduction of idle emergency equipment has had the result of enabling the electric-construction dollar to go farther than formerly. This may account for much of the 1928 decrease of utility capital growth.

It is interesting to note that the utilities (this group includes electric light and power, water, gas, telephone and telegraph, but not steam railroads) today consume about one-tenth more new capital than do the states and municipalities. Six years ago the comparison was reversed, the municipalities then investing about 50 per cent more in construction than the utilities.

To summarize the case, the country's construction activities are reflected by the current issues of new capital, all of which moneys are obtained for expansion of productive facilities, whether plant or machinery. The totals of these figures show a huge increase in construction activity, well maintained, almost doubling the yearly total between 1922 and today. The curves and figures of distribution among the several industrial groups are significant in showing an increasing rate of activity in the fields of the utilities, general manufacturing, and state and municipal facilities. In railroads and the metal-producing industries, growth has been more steady, calling for about a constant amount of new capital each year.

Steel Railway Bridge Standard Specifications Approved

The Board of Railway Commissioners of Canada has acted favorably on the application of the Canadian Engineering Standards Association for approval of the standard specification for steel railway bridges. The consent of the Canadian Pacific and the Canadian National Railway companies had previously been obtained. All prior orders approving standard specifications for steel bridges and viaducts are rescinded.

Core Tests Lead to Proportioning by Weight

Change From Volume Mixtures Looking Ahead to Designing for Given Strength Follows Two Years' Core-Drill Work

By C. E. Forster

Construction Engineer, State Highway Department, Lansing, Mich.

What Concrete Strengths are being obtained in pavements? The state highway engineers in Michigan have been making a large number of core-drill tests which indicate that they are highly variable. As the result Michigan will no longer proportion its pavement concrete volumetrically. The tests and the conclusions and the decision to change methods are interesting and they are presented in this article, written from a talk Feb. 17, 1928, at the annual highway engineering conference, University of Michigan. —Editor.

The State Highway Department of Michigan began to core-drill pavements in 1922, the object being to determine whether or not proper thickness of slab was being secured. Since that time one and sometimes two core-drill outfits have been operated during the greater part of each construction season. Each year since 1922 a few cores from individual projects had been crushed to determine the strength of the concrete. In 1926 a larger number of specimens were tested and the results arranged in such a way that they could be studied. This work was continued during 1927; the data for both years follow in the form of a series of graphs, Figs. 1 to 4.

Fig. 1 shows the average strength of all of the cores crushed during 1926. It can be noted that the average strengths fall into a fairly regular curve. Fig. 2 shows the strength of individual cores on a typical project; there are large variations in strength of the individual specimens. Fig. 3 shows the strength of individual cores by age selected from several projects for the purpose

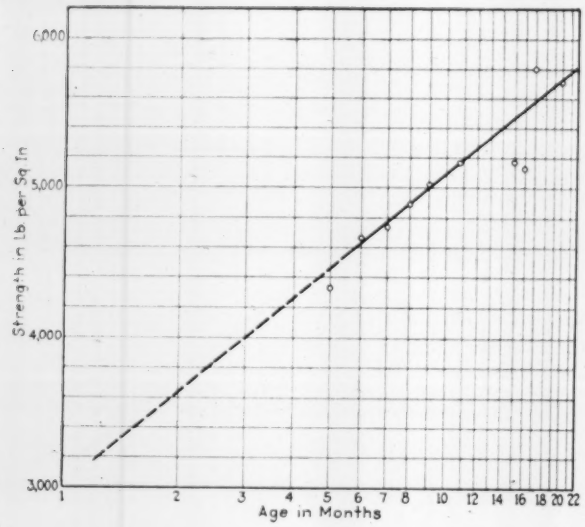


FIG. 1—AVERAGE STRENGTH OF 1926 PAVEMENT CORES BY AGE

of studying the strengths of the individual specimens as well as the average strength in the entire age range. The heavy dotted line connects the average strengths at the various ages. The curve showing the average strengths in 1926 (Fig. 1) superimposed on these data indicates a very general conformity to the averages of the previous year. However, the striking thing in connection with this graph is the lack of uniformity of strength between individual specimens. Fig. 4 is a study of the average strengths of cores of an average age of 205 days on nineteen different projects. The strength range on these projects should be noted.

Before any conclusions are drawn the facts should be briefly reviewed: First, it has been shown from the strength charts that there is a decided lack of uniformity in the strength of concrete on the individual projects, the difference in strength of individual specimens of the same age being as much as 2,500 lb. per sq.in. Second, on some projects it has been shown that the average strength of a group of specimens at two or three months of age is higher than the average strength of another group of specimens much older. This is contrary to the behavior of carefully controlled laboratory concrete, which under ordinary conditions grows stronger with age. Third, it has been shown that there is a decided lack of uniformity in the average strength of concrete of the same age on a group of projects, the total range of difference in strength on the projects studied being upward of 2,800 lb. per sq.in. Fourth, visual inspection of the individual cores shows segregation of fine and coarse aggregate, porosity and other defects.

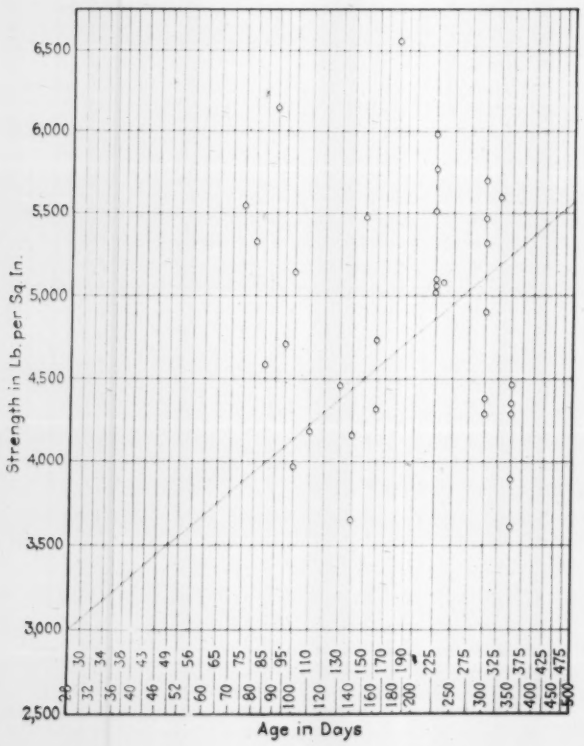


FIG. 2—STRENGTH BY AGE OF INDIVIDUAL CORES ON ONE PROJECT

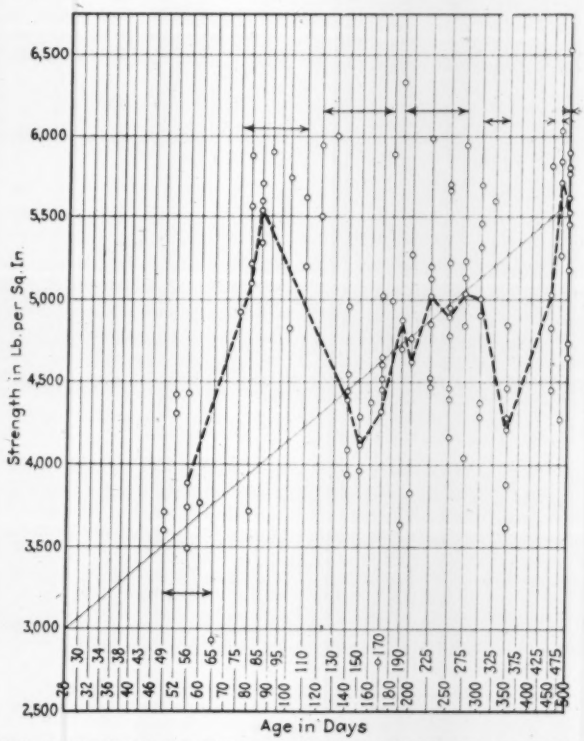


FIG. 3—STRENGTHS OF INDIVIDUAL CORES AT VARIOUS AGES FROM SEVERAL PROJECTS

When considering these facts it must be remembered that the specimens tested are actual samples taken from the pavement. The crushing strengths, therefore, represent strength of the pavement—barring improper handling of specimens prior to testing and natural errors in capping the cores and testing them. It should also be borne in mind that all of the materials which went into the construction of the pavements represented by these specimens passed laboratory inspection and met the requirements of the specifications. The construction methods prescribed by the specifications were followed out as nearly as it is possible for different engineers to interpret the meaning of the specifications and apply the principles to their work.

It must be borne in mind that there is a human element in the application of these construction methods. But from the observation of many jobs in the field it would appear

that the average interpretation of these methods has been well within the intent of the specifications.

Granting that these facts are true, it must be admitted that working under the old volumetric specification for proportioning concrete aggregates the strength of the concrete cannot be predicted or controlled unless greater attention is given than heretofore to several factors: (1) Segregation of aggregates, (2) volumetric changes in the aggregate due to the presence of varying quantities of moisture, and (3) total quantity of water per batch of concrete.

In other words, to secure uniformity of strength on even a single project it must be possible easily to control the amount of fine aggregate, the amount of coarse aggregate and the amount of water in each batch of concrete. It is possible to correct for varying conditions in aggregate when using the volumetric method of proportioning, but it is admittedly impracticable, since to secure good results changes in batch size might be required several times daily, with consequent delay in the operation of the plant. It has been demonstrated that weight measurement of aggregates is practicable and flexible, and that with this method of measurement fluctuating conditions of aggregate and moisture cause much less disturbance of the total mineral aggregate in each batch. Adjustments in proportions are also easily possible involving no more labor than is necessary to change the weights on the scale beam.

In view of the results of core strength tests the Michigan State Highway Department specifications for 1928 paving provide for the proportioning of concrete aggregate by weight and accurate measurement of total water content. For the present the proportions of cement, fine aggregate and coarse aggregate will be based upon the characteristics of the materials themselves in combination such as to develop the maximum strength with a given cement content per cubic yard of finished concrete. Careful studies are being made of all available aggregates; when these are completed and test results of field concrete made over a period of time, advantage may be taken of the data secured to effect economy by designing for a given strength.

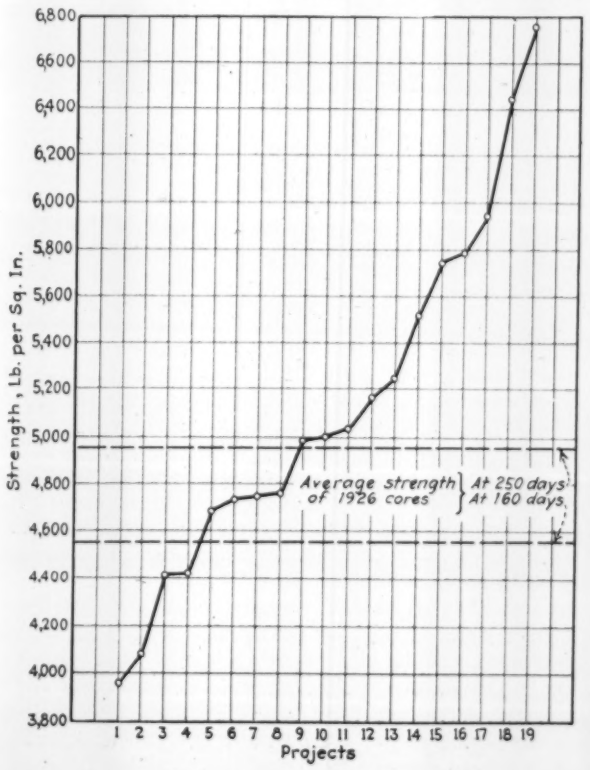
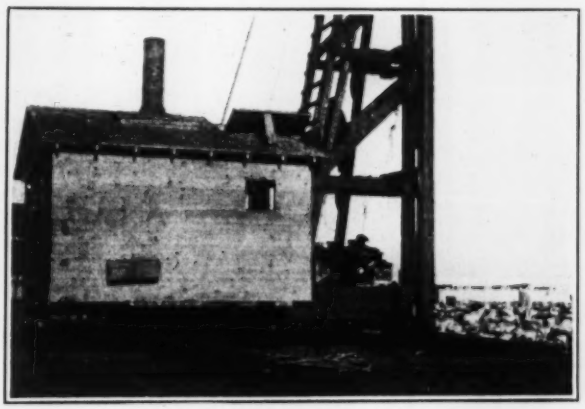


FIG. 4—STRENGTH VARIATION OF CORES OF SAME AGE BY PROJECTS

Simple Roller Mounting for Piledriver

By E. Smith
Port Arthur, Ont.

A PILEDRIVER mounting somewhat different from the usual is shown in the accompanying illustration. The rollers consist of two round oak logs 12 in. in diameter and 24 ft. long. In each end of the logs there are 1½-in. steel dowels extending 10 in. out from the end, and also 4-in. steel bands to prevent the log from splitting. The ends of the two rollers are connected by a frame made of two ship channels placed back to back and held 2 in. apart by fillers. The steel dowels project through the spaces between the channels and are held in place by oak fillers. In this case the rollers were spaced 14 ft. c. to c.



PILEDRIVER ON ROLLERS FOR EASY MOVEMENT IN ANY DIRECTION

A framework 24 ft. long and 5 ft. wide, made of 12x12-in. timber, rests directly on the rollers and is held in place by recessed blocks bolted to the under side. Upon this framework the piledriver is set up, the leads at one end and the boiler at the other.

By attaching suitable blocks and falls to anchors, the piledriver can be moved by its own power forward, backward, or to the side. If more lateral motion is desired than the length of the rollers permits, it is easy to jack up the framework on blocks, thus taking the weight off the rollers, and by attaching a line to the channel frame skid the entire roller system to proper position.

A rough track for the rollers is made by laying 10x12-in. timbers directly on the ground.

Railway Electrification in Italy

A statement by the Minister of Communications shows that electrification on the Italian state railways now includes 1,054 miles completed or nearly completed and 347 miles authorized for early construction, while on the secondary railways owned by private companies there is a total of 623 miles of electrified lines, making a grand total of 2,024 miles.

Research in Materials Distinguishes A.S.T.M. Meeting

Development of Specifications Overshadowed by Investigation of Materials and Test Methods—Scope of Society's Work Continues to Broaden —F. B. Jewett Reviews Transatlantic Radio Telephony, and H. F. Moore Memorializes the Discoverer of Hooke's Law

RETURNING to its long-accustomed convention place, Atlantic City, the American Society for Testing Materials last week gave proof of the vitality of its work both by large attendance and by vigorous activity. Its specifications committees brought forward 30 or 40 new specifications, besides a larger number of revisions. However, this work was overshadowed by research work of the committees as well as of corporations and individuals.

Among the important results of such work reported to the meeting were new facts on fatigue of steel and cast iron; yield point of structural steel; wear of bearings, tire chains, crusher jaws, flooring; seizing of bearing metals at high temperatures; cement and concrete testing; and flow or creep of steel.

A very much larger amount of work was reported as under way. Special items of this current research are several elaborate series of corrosion tests, a study of die-casting alloys, investigation of the weathering of different materials, tests of rubber products (abrasion, life, flexing and shock), and hardness of slate.

Special research committees are dealing with effect of tin and arsenic on high-speed tool steels; effect of sulphur and phosphorus on steel; determination of yield point of structural steel; effect of temperature on the properties of metals; and fatigue. The latter committee is just being organized to take over the correlating work of the former fatigue-of-metals research committee of the National Research Council and the Engineering Foundation. A new committee to study iron-chromium-nickel alloys is shortly to be organized.

Joint committee work is going on in the fields of concrete culvert pipe, inclusions in forgings, molding sand, springs, rock drill steels, boiler-feed water, annealing of chains, weathering and several other subjects.

Two Interesting Addresses

Dr. Frank B. Jewett, president of the Bell Telephone Laboratories, delivered the third Edgar Marburg lecture, on "Some Research Problems Involved in Transoceanic Telephony." He traced its origin to trials begun thirteen years ago and resumed in 1920 after interruption by the war. Among the technical difficulties that had to be overcome, besides the development of large-power vacuum tubes—batteries of 10-kw. tubes are now being used—were those due to working on the same wave length in both directions, volume control of the final output, etc. Administrative difficulties included the harmonizing of the different calling and operating methods in American and European telephone practice and the necessity of clearing the frequency channel of many interfering uses by international action. Short-wave-length working is now under investigation, to make more channels available. Commercial service began in January, 1927, but was not extended to the Continent until this year. Since April calls have averaged 37 per day, with a maximum of 61.

The presidential address, delivered by Prof. H. F. Moore, of the University of Illinois, dealt with the 250th anniversary of Robert Hooke's public announcement of the proportionality of stress and strain: "*De Potentia Restitutiva:* Of Spring, Explaining the Power of Springing Bodies." Speaking of the famous Hooke's law, Professor Moore said that

> It is one of the basic assumptions of present-day computation of strength of materials; the routine computer, the testing engineer and the mathematical elastician all accept it as a basis for their work. It has had an influence on the development of the mechanical age comparable to the first and the second laws of thermodynamics, comparable to Ohm's law of electric currents, comparable to the law of definite proportions in chemistry. No structural engineer designs a beam, no machine designer determines the size of a shaft, no testing engineer makes a transverse test or a torsion test without using reasoning or formulas based on this law. The great Galilei himself, perhaps the first materials engineer of history, lacking knowledge of this relation between force and elastic deformation, failed to establish methods for determining the strength of beams of any cross-section other than rectangular. . . .
>
> As is often the case with the formulators of physical laws, Hooke seems to have had no idea of the great importance of his law of springy bodies. He always had his vital interests in apparatus and machines and devices rather than in abstract laws—in his spring watch, his plan for the rebuilding of the burned part of London, in his job as city surveyor to lay out the new city according to the accepted plan drawn up by Sir Christopher Wren.
>
> Yet, whatever his limitations and his lack of vision, he has left us a great fundamental working rule which has served acceptably for a quarter of a millennium—just about as long as have the laws promulgated by the great Newton. Robert Hooke's thumbmark is on every structural shape and on every stress-carrying forging or casting; it is on every concrete arch and beam, on every timber bent and post. He takes his place among the chemists and the metallurgists and the electricians and the steam engineers who ushered in the mechanical era. And so tonight, after 250 years, we pay our tribute to Robert Hooke, the man who taught us to say "As the stretch, so the force."

Dudley Medal to DeForest—A. V. DeForest, research engineer of the American Chain Company, Bridgeport, Conn., was awarded the Charles B. Dudley medal for a paper presented last year, "A Method of Graphic Representation of Magnetic Characteristics."

Specification Work

Specification work formed fully half the subject-matter of the meeting, as is customary with the society. Few basic specifications were involved except in specialty fields, as the main work on the commoner materials was done in previous years, except for progressive revision. In practically all cases the recommendations of the committees were adopted by the meeting with little or no discussion. In the field of the more important engineering materials the following new developments were reported, among others:

New specifications for iron and steel chain, including electric cast; American standard specifications for cotton rubber-lined fire hose; revision of structural steel specifi-

cations to include copper steel (minimum 0.20 per cent copper); new specifications for steel pipe for ordinary uses; new specifications for galvanized structural steel products; specifications for bronze castings and silver solders; a new abrasion test method for gravel; proposed specifications for concrete pavements and bases; new specifications for sand-lime brick and revised specifications for concrete brick, building brick and paving brick, together with new test methods; revision of hollow-tile specifications.

New Standing Committees—Three new specifications committees have been authorized: on cast copper alloys, on light alloys and on white-metal alloys.

Weathering phenomena are to be studied jointly by several committees whose materials are affected.

Investigations by Committees

Investigational Work—In connection with their specification work the standing committees are carrying on many investigations. Besides those for which results are noted below, the following items of work in progress may be of interest:

Cast Iron—Relation of casting to test-bar strength (some results reported, see Fig. 1); heat-treating practice; fatigue strength (some results reported by Kommers, below).

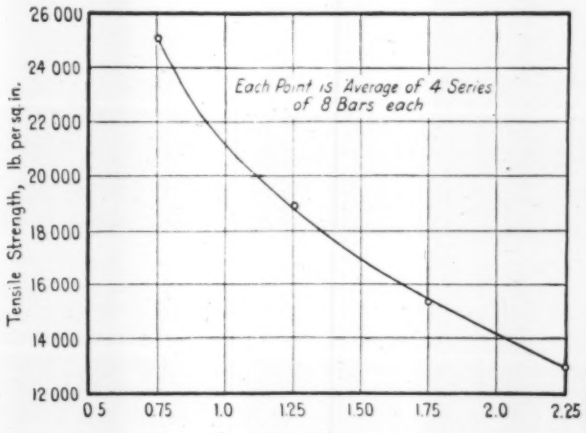


FIG. 1—EFFECT OF SIZE OF CAST-IRON TEST BAR

Tensile strength of 0.505-in. diameter test pieces cut from cast bars of various diameters from ¾ to 2¼ in. The modulus of rupture in bending tests varied somewhat similarly. A study made at the Cleveland foundry of the Westinghouse Electric & Manufacturing Company, and reported by the committee on cast iron.

Wrought Iron—Effect of forging, pressing and rolling; nature of quality; effect of phosphorus.

Rubber Products—Abrasion tests; aging tests.

Non-ferrous—Properties of bearing metals.

Steel—Atmospheric corrosion of galvanized sheets.

Alloy Steel— Durability of electrical resistance wire.

Lime—Cause of plasticity.

Paint—Vehicles; preparation of steel surfaces.

Screen Wire Cloth—Life of various types.

Brick—Condition in old buildings.

Drain Tile—Chemical test requirements.

Preservative Coatings—A further report in the comparative tests of hand-brushing versus spraying of paint was made by a subcommittee of the committee on preservative coatings for structural materials. The test painting was done in 1921 and a previous report was made in 1925. Briefly, the report summarizes conditions as they existed six years after the paint was applied. All the paint is chalking rather freely, but no difference was found between that which was brushed on and that sprayed. Only in the case of one house, that upon which the most paint was used, was there any difference, that house being in the best condition.

Corrosion Tests—Corrosion tests of uncoated iron and steel sheets, in progress for many years (Pittsburgh, Annapolis, Fort Sheridan), gave some further results, confirming prior findings.

At the close of eleven years' observations the failures at the Fort Sheridan location confirm the findings at the Pittsburgh location that copper-bearing metal shows marked superiority in rust-resisting properties as compared with non-copper-bearing metal of substantially the same general composition under atmospheric exposure.

The Fort Sheridan test was discontinued last April; the Pittsburgh test having been ended five years ago, only the Annapolis test is still running.

Total immersion tests, on the other hand, show no perceptible influence of copper. In Washington city water No. 22 sheets lasted 740 to 967 days, and No. 16 sheets, twice as thick, about twice as long; or 1,747 to 2,074 days. Brackish water at Annapolis shows less rapid rusting. Seawater tests at three locations have produced no results as yet.

Acid Test for Corrosion Resistance—By special resolution the steel corrosion committee reaffirmed its non-committal attitude of seventeen years ago on the value of accelerated acid tests as a measure of corrosion resistance: "The committee desires at this time to again disclaim any recommendation or indorsement of the acid test as a measure of natural corrosion, and to point out that any use of the name or authority of the American Society for Testing Materials in this connection is unwarranted."

Fatigue and Endurance

Fatigue and Corrosion—Among the most prominent additions to knowledge of materials brought out at the meeting were new data on fatigue and the closely related "corrosion fatigue" given in two papers, one by D. J. McAdam, Jr., of the Naval Engineering Experiment Station at Annapolis, and one by F. N. Speller, I. B. McCorkle and P. F. Mumma, of the National Tube Company. Dr. McAdam greatly extended and confirmed his previous inferential demonstration that the combined action of corrosion and cyclic stress produces its endurance-lowering effect by pitting, notch formation and stress concentration. He showed in particular that torsional fatigue tests produce incipient cracks of cross shape on 45 deg. axes with the length and therefore across the direction of resultant maximum tensions. By developing several new forms of diagrams for plotting the test results he brought out the relation between pitting, notching and destructive stress concentration in clear and convincing manner.

General support was given to these findings by the investigations of Speller and associates, which showed that corrosion inhibitors (as a bichromate) will raise the corrosion-fatigue limit up to the original fatigue limit; and that special conditions which form local electrolytic concentration cells will lower the corrosion-fatigue limit even below its normal position. The results of the work may help to reduce fatigue breakage of rotary drilling pipe. Abstracts of the two papers will be given later.

New endurance data were also brought forward by Prof. J. B. Kommers, of the University of Wisconsin, who tested cast iron in fatigue. It was found that the endurance of cast iron is roughly related to static tensile

strength, to modulus of rupture and to hardness, but not to chemical composition. However, actual fatigue tests should be made to check any endurance inferences from static strength. Dr. H. W. Gillett, of the Bureau of Standards, and others suggested that with so variable a material as cast iron the plotted fatigue values require drawing a zone or belt of endurance rather than a single line; and possibly the same thing should be done for steels.

Wear of Metal—Metal wear tests were the subject of several papers and reports. One by J. M. Blake, engineer of tests, American Manganese Steel Company, related to the resistance of various steels to wet grinding, and described a machine developed for the purpose by F. A. Fahrenwald. The author stated that for reasons not yet clear there is a difference between the abrasion resistance of a steel under wet grinding conditions on the one hand and dry crushing conditions on the other. Oxidation has been found to be an important factor, but it cannot explain all results.

Yield Point of Structural Steel—A research committee on yield point of structural steel presented a first report after two years' work under the chairmanship of Prof. M. O. Withey, of the University of Wisconsin. A large number of $\frac{3}{4}$-in. round bars and a group of specimens cut from plates and rolled shapes were tested in five different laboratories at different machine speeds and with several methods of detecting the yield point (drop of beam, dividers, extensometer, scaling). The results showed the drop-of-beam and divider methods to be best, and showed that machine speed affects the yield-point determination but does not influence ultimate strength or elongation. By increasing the machine speed (in the vicinity of the yield point) from 0.05 in. to 2 in. per minute, the yield point was raised by 3,900 lb. per square inch for carbon steel, 4,800 lb. per square inch for nickel steel and 6,500 lb. per square inch for silicon steel.

Data were obtained on the variation of yield point across a plate or rolled shape, showing among other things that the variation is greatest in I-beams and least in plates, but a further series of tests on this variation is to be made. At present it appears that specimens from the middle of width of the outstanding flange of an I-beam give the best representation of the average yield point of the whole shape. The latter point was also brought out by other data in a paper by Professor Withey summarizing the results for a number of I-beams, channels, angles and plates in connection with tests of built-up columns made for the column research committee of the American Society of Civil Engineers. As stated by Dr. L. B. Tuckerman, of the Bureau of Standards, the same result was found in tests at the bureau, 1920-25. He said that the most important showing of the Withey tests was that the consistency of the results was not reduced, but if anything increased, by increase of speed of testing. Prof. T. R. Lawson, of Rensselaer Polytechnic Institute, reported that at the moment Lüders lines appeared on the tension specimens there was a halt in the load which at slow speeds might give a false drop-of-beam indication.

Locating Yield Point—After criticising various artificial methods for defining the location of yield point (Johnson limit; point of 0.5 per cent total strain), J. M. Lessells, of the Westinghouse Electric & Manufacturing Company, proposed that it be defined as the point of 0.2 per cent *plastic* strain. J. A. Capp, of the General Electric Company, and H. F. Moore, of the University of Illinois, questioned the wisdom of introducing a new definition or location of the end point of elastic action, and Mr. Capp pointed out that any attempt to ascribe a yield point to materials which do not have definite yield is bound to lead to contradictions.

Flow or "Creep" of Steel—J. J. Kanter and L. W. Spring, of the Crane Company, Chicago, reported extensive tests made upon various steels by a steady-load tension machine in which the specimen was maintained at high temperature, such as required in oil-refinery and modern steam power service. Test pieces of 0.505-in. diameter are used. The resistance furnace surrounding the specimen can maintain temperatures of up to 1,400 deg. continuously, and a controller can maintain the temperature constant within 5 deg. A telescopic reading device enables stretch to be measured. Runs have been made up to several thousand hours.

P. G. McVetty, of the Westinghouse company, dealt with short-time and flow tests at high temperatures, discussing the many complications of such tests.

Sulphur in Cast Iron—In "The Effect of Sulphur on the Physical Properties of Gray Iron," E. K. Smith and F. B. Riggan showed that increasing sulphur does not affect tensile or bending strength but does increase the hardness and the combined carbon.

Cast-Iron Pipe—Extensive tests of sand-cast and metal-mold centrifugally cast pipe were made for the Detroit Water Board by Profs. F. N. Menefee and A. E. White, of the University of Michigan. As they reported the results (to be abstracted later), the primary criteria in part favored one and in part the other make of pipe. However, the discussion brought out differences of view as to the adequacy of the tests and comparisons.

T. H. Wiggin, of New York, outlined the work being done by the A.E.S.C. national committee on cast-iron pipe. Special studies are being made of trench loads, corrosion, cement lining, bituminous coatings and the relation between pipe strength and test-bar strength.

Brittleness—Tests of brittleness of flat steel springs, in which many of the uncertain results usually associated with such tests had been eliminated, were described by P. L. Irwin, of the Westinghouse Electric & Manufacturing Company. The improved results had been obtained by using a flexure test instead of the more ordinary tension test.

Tests on Welded Seams

Weld Testing—W. B. Miller, of the Union Carbide & Carbon Research Laboratories, described the conditions of successful gas welding of some high-chromium alloys, though without giving details of the flux to be used. He favored testing welded seams by bending transverse to the seam, and stated that direct tensile elongation over the weld is misleading. This point led to some discussion, in which J. H. Hall and J. M. Lessells questioned the propriety of disregarding the direct elongation. H. E. Smith pointed out that the bend test may measure the integrity of the weld and the tensile test the integrity of the structure; in copper welding of steel fireboxes, for example, the distinction was important.

Tension and torsion test data on nickel, 2 and $4\frac{1}{2}$ per cent manganese-nickel, and copper-nickel alloys were presented by W. A. Mudge and L. W. Luff, showing that certain of these metals have very great toughness. Further data were added by N. L. Mochel and by D. J. McAdam, Jr.

In the report of the non-ferrous metals committee, besides a considerable amount of specification work, the main feature of interest was announcement of the or-

ganization of an elaborate study of die-casting alloys, which will cover more than 50,000 test pieces. Both aluminum-base and zinc-base alloys will be included.

Portland Cement

Variation of Tests Results—The remarkable comparative study of cement testing which has been carried on by the cement committee for a number of years was finally reported upon at this year's meeting. It covered 32 cements, tested by 47 laboratories, and included more than 63,000 strength tests alone. Generally its result is negative, giving no indication of trends and showing wide variation of results among different laboratories. The fluid-paste test proposed some years ago proved disappointing both as to uniformity of results and as to agreement with concrete compressive strength. No clear-cut relations between cement composition and concrete strength were found. In general

> Whether a cement is meeting the requirements of the standards seems now too frequently to be a matter of choice of laboratory. Hence the advisory committee has been instructed to appoint a committee to study this situation along the lines of establishing a special laboratory where instructions can be given in carrying out the tests according to the prescribed methods, where the equipment used in testing could be calibrated and examined to see if it meets with the desired requirements, and which can, when so requested, act as umpire in settling disputes among laboratories as to any test requirement.

The committee concludes that the present tension briquet test is inadequate as an indicator of concrete

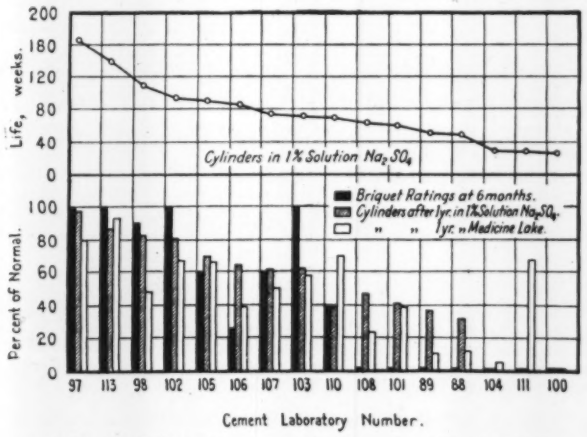


FIG. 2—CEMENT MORTAR SPECIMENS IN SULPHATE WATERS

Cements from sixteen plants compared by different methods. Upper curve shows time to disintegration of test cylinder. Lower blocks show visual ratings of half tensile briquets in 1 per cent sodium sulphate at six months, and one-year ratings of cylinders in two different waters. Large differences between the cements are shown by all the tests in agreement.

strength, and "will look to the development of entirely new methods."

Action of Sulphate Waters—Long-time tests of 30 portland cements both in the natural alkali water of Medicine Lake, S. D., and in 1 per cent solutions of sodium and magnesium sulphates either separately or mixed, carried on by a group of federal and Minnesota agencies, were reported by D. G. Miller, of the Bureau of Public Roads. The tests showed large differences in resistance among different cements, the best being eight times as resistant as the poorest; the field exposures roughly paralleled the laboratory tests (Fig. 2). No correlation could be found with either physical tests or chemical analyses, but an effect of the geological origin of the raw materials is suspected. A six months' test in 1 per cent solution of either salt is tentatively suggested as criterion for resistance to sulphate waters.

Mortar Tests With Graded Sand—E. M. Brickett reported the development of a plastic-mortar compression test for cement at the Lehigh Portland Cement Company. The test correlates well with the standard concrete compression test, shown by the curves in Fig. 3, which cover seventeen cements from the company's different mills.

The test is made on 3x6-in. cylinders of about 1:2:3 mix with definite grading, mixed to a consistency of 80

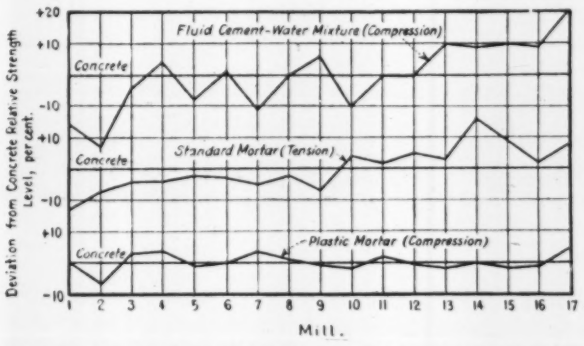


FIG. 3—PLASTIC MORTAR COMPRESSION TEST COMPARED WITH TWO OTHER CEMENT TESTS

Ordinates are variations from uniform ratio to concrete strength.

per cent on the flow table (about 1.0 water-cement ratio, or 7½ gal. per sack), cured at 70 deg. F. and 100 per cent humidity after four hours, tested at six ages from one day to 28 days. The mortar is plastic by virtue of the aggregate grading, and hence works better and more uniformly than standard-sand mortar. Further study and development work are to be done.

Long-Time Volume Changes—Prof. A. H. White's long-time studies of the expansion and shrinkage of neat-cement bars, at the University of Michigan, formed the subject of another paper, adding some data to those he has reported previously. The work covers 153 bars of commercial and laboratory cements, at ages of 4 to 27 years; the paper showed curves for 46 of the bars. Magnesia was found to cause undue expansion in water when there was enough free lime to liberate the magnesia.

Developments in Concrete

In addition to a rather full committee report on concrete and aggregates, the subject of concrete brought out a number of new test results and other developments. The committee report included interesting sub-committee discussions of design of concrete mixtures (R. B. Young), abrasion tests of stone and gravel (Stanton Walker), and effect of admixtures in water ratio (George Conahey). Work in progress includes standardization of the bending test, study of volume changes, workability tests, and apparatus design.

W. F. Purrington and H. C. Loring, of the New Hampshire Highway Department, made an interesting innovation in the study of workability by measuring the power required to mix a definite amount of concrete in a small tub-type mixer equipped with revolving paddles driven at 23 r.p.m. by an electric motor.

It was found that different cements gave quite different power curves. In general the richer mixes took more power. The curves gave clear indication of when mixing was complete.

Measuring workability by a piledriver type of pene-

trometer was dealt with by G. A. Smith, of Lompoc, Calif. The instrument was described before the American Concrete Institute last February, but the present paper cited some confirmatory tests.

Accelerated Freezing Tests—Because of concrete disintegration from both alkali and freezing action in Kansas highway bridges the Engineering Experiment Station of Kansas State College made field exposure tests and also investigated the effect of alternate freezing and thawing at an accelerated rate, up to several hundred cycles, reported by C. H. Scholer. Unsound stone and lean concrete were found to be factors in the disintegration, but with unsound aggregate even rich mortar gave little protection to the stone. For durability the water-cement ratio must not be greater than 1.0. The freezing cycles were run in a mechanical refrigerator; the specimens, placed in a can of water set in alcohol, were carried down to —15 or —20 deg. F., and then thawed in water at about 70 deg.; three cycles a day could be run.

The Flexure Test—Comparative flexure tests with several types of cantilever machine and with simple-beam loading, carried out for the Missouri Highway Commission and reported by T. F. Willis and F. N. Wray, showed large variations in the computed modulus of rupture. It was concluded that the flexure test machine should be standardized, if comparisons are to be possible.

Strength Relations—A large series of compression, bending and tension tests of plain concrete was reported by H. F. Gonnerman and E. C. Shuman, of the Portland

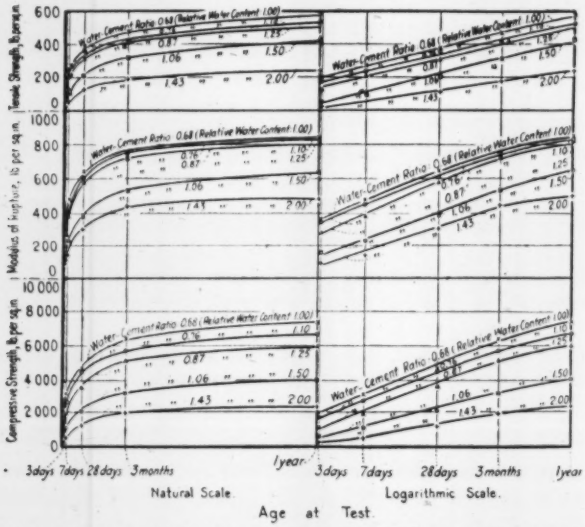

Compressive Strength, lb. per sq. in. | Modulus of Rupture, lb. per sq. in. | Tensile Strength, lb. per sq. in.
Water-Cement Ratio 0.68 (Relative Water Content 1.00)
0.76 " " 1.10
0.87 " " 1.25
1.06 " " 1.50
1.43 " " 2.00
3days 7days 28days 3months 1year
Natural Scale.
3days 7days 28days 3months 1year
Logarithmic Scale.
Age at Test.

FIG. 4—VARIATION OF CONCRETE STRENGTH WITH AGE FOR DIFFERENT WATER RATIOS

Compression tests, 6x12-in. cylinders; tension tests, 6x18-in. cylinders; flexure tests, 7x10x30-in. beams; 1:4 mix with graded Elgin sand and gravel; specimens cured and tested moist—Gonnerman and Shuman

Cement Association's research laboratory. The tension tests were made on 6-in. cylinders held in friction grips. All results were of gratifying regularity and consistency. (See Fig. 4.) It was shown that tensile and bending strength depend on water-cement ratio quite the same as does compressive strength, but that undersanded mixes may show high modulus of rupture, although both tensile and compressive strengths are low, indicating that when flexure tests are used for field control of concrete quality they may at times indicate unduly high quality. Generally the tensile strength was half the modulus of rupture, or slightly higher, while the latter was one-fifth to one-seventh of the compressive strength. With a soft sandstone aggregate, however, the compressive strength often was unduly high in relation to tensile and bending strength.

Bond Tests—Pulling-out tests of 1-in. rods molded in 8x8x12-in. concrete blocks made with varying cement ratios and with several different sands were reported by L. N. Edwards and H. L. Greenleaf, of the Maine Highway Commission. About 200 pieces were tested, as well as half as many compression cylinders.

Permeability—Prof. Ira L. Collier, of the University of Washington, reported permeability tests on specimens of 9-in. diameter and 8-in. height under 145 lb. water pressure. He deduced the formula $p = 0.007x^{15}$, where p is the flow in gallons per hour and x is the water-cement ratio.

Gypsum Concrete—Tests have been started to determine the properties of gypsum fiber concrete as a basis for more definite design of poured-in-place gypsum construction.

Mixtures of gypsum and anhydrite tried as retarders in portland cement have given good results. Mill trials are to be run as checks.

Sewer and Drain Pipe

No particular progress was made in standardization of sewer, drain or culvert pipe except for the joint committee report. The subject was discussed in two papers: "Tests of Clay and Concrete Load-Bearing Pipe," by W. J. Schlick, of Iowa State College, and "The A.S.T.M. Specifications for Sewer Pipe and the Fiber Strength of the Material," by F. B. Lysle, of Philadelphia. Mr. Lysle showed that present standards of pipe thickness produce greatly different strengths against crushing, as measured by calculated modulus of rupture, and proposed a new scale of thicknesses.

Joint Committee on Culvert Pipe—Since 1919 seven technical societies have been co-operating in the development of specifications for concrete culvert pipe for railway and highway use. A tentative specification was reported in 1926, but important revisions have been found desirable and a revised specification is therefore now reported. The amount of circumferential reinforcement has been reduced, an absorption test has been added and new requirements for extra-strength pipe have been inserted. The specification contemplates two stock weights of pipe but gives the means for designing special weights for any desired service.

Brick, Stone and Lumber

Compressive Strength of Brick Masonry—Results of extensive tests made in the Bureau of Standards laboratories were reported by J. W. McBurney of the Common Brick Manufacturers' Association, Washington, in a paper on the effect of strength of brick on compressive strength of brick masonry. The conclusions are that flatwise compressive strength of brick is the most consistent measure of masonry strength, and that change of mortar strength has more influence in case of strong than in case of weak brick.

Discussion centered around the need for extending these tests to other types of brick such as shale, stiff mud and side-cut brick, also that tests should be made with the same class of mortar as was to be used in the masonry for which the bricks are intended. Prof. T. R. Lawson, chairman of the brick committee, pointed out that the method of manufacture was an important factor, that architects and engineers must know the peculiarities of

the local brick with which they have to work. He also suggested that, instead of using plaster cushions in applying loads to test specimens, planed bricks capped with a flat plate be used.

Absorption—In reporting important tentative specifications for various types of brick, the committee on brick, having withdrawn the absorption test from the present tentative specification for clay or shale brick on the ground that it was not a reliable measure of resistance to weathering, made the following statement in regard to absorption:

> There appears to be a widespread belief that the percentage of absorption of individual bricks is a governing factor in the ability of brick masonry to resist moisture penetration. It has been conclusively shown that such a belief is erroneous. On the contrary, a certain amount of absorption in the brick assists in obtaining a better bond between brick and mortar and therefore a more watertight joint. Any water penetration in brick masonry undoubtedly passes largely through the mortar joint and not through the brick. This committee has always felt that if absorption percentage has any significance, it is as a possible measure of that quality of brick masonry known as durability.

Efflorescence and Staining—Brown stain on limestone and efflorescence on masonry walls was the subject of a discussion which centered around a paper by Lee Huber, research engineer, Indiana Limestone Company, Bedford, Ind., concerned chiefly with the staining of buff limestone. The character of the backing mortar was found to be the chief cause of trouble. Gypsum retarder was among the worst offenders. Seepage through the masonry or the evaporation of water which has been absorbed into the wall from the surface is essential to the formation of efflorescence. Staining of buff limestone, according to Mr. Huber, is the result of a similar process, but in the case of limestone exposed to weather the stain soon disappears.

Fire Tests on Construction Materials—The committee on fire tests of materials and construction reported that following the recommendations made to it during the fall of 1927 to the effect that suitable fire tests should be made to determine the fire resistance of combustible materials, both natural and treated to render them more fire resistant, it had determined to undertake such tests but to confine them to lumber for the present. The tests are not to be limited to any one method of treatment. They are to apply to materials which go into the finish of buildings, not to structural members.

Other Papers

Abrasion Tests of Aggregates—Data upon the effect of the number of revolutions of the cylinder, weight of the sample, number of balls in the abrasive charge, grading of the sample and the shape of the aggregate particles in making Deval abrasion tests on aggregates were given by Stanton Walker, of the National Sand and Gravel Association. While no recommendations were made as to the best method of procedure, certain important conclusions as to the percentage passing sieves and to the fineness modulus were given, also as to variations in the weight and size of the sample. Discussion brought out the fact much less rigid requirements than those of the Deval test are required for aggregate for concrete, as resistance to wear is not so important as soundness, although generally the softer stones do not make as sound concrete as the harder ones. Also, it was stated that the value of such tests is only relative, as it usually is necessary to set abrasive limits to suit local materials.

Gas and Oil—Gasoline and motor oils were the subjects of two papers before the session on petroleum products and brought forth no little discussion. "The How and Why of Gasoline Performance" was the subject of a paper by J. Bennett Hill, chief chemist, the Atlantic Refining Company, Philadelphia, a paper in which he characterized all criteria for good gasoline of former days such as color and gravity as useless now and put all special gasolines in the class of luxuries designed to meet special conditions but not so good as ordinary gasoline for all-around usefulness. "The Significance of Various Tests Applied to Motor Oils," a paper by Robert E. Wilson, director of research, and D. P. Barnard, 4th, director, engine laboratory, both with the Standard Oil Company (Indiana), Whiting, Ind., indicated how dependent on the refiner is the user of motor oils not equipped to make his own tests. The paper also pointed out how many of the tests frequently made checked results which had little to do with performance. Two properties of possible importance to users, oiliness and resistance to oxidation, properties for which no satisfactory tests have been devised, also were discussed.

Abrasion Tests on Rubber—Difficulties in attempting to duplicate service conditions in abrasion tests on rubber were described in a paper by Harlan S. Depew, research division, New Jersey Zinc Company, Palmerton, Pa. As abrasion resistance is not a fundamental property of rubber stock but rather the resultant of its resistance to cutting and tearing, Mr. Depew believes that these two properties should be measured separately so that the service qualities of any rubber stock for different conditions can be more accurately judged. Attempts made by his company to develop an abrasion-testing apparatus for rubber in which sheets of it were held against a rotating metal track indicated that inaccurate results were obtained with some classes of rubber, particularly the extremes of hard and soft. This condition indicated that the tearing conditions of service were lacking and consequently the device was modified to raise and drop the test specimen on the track at frequent intervals.

Wear Tests on Floors—Experiments by the U. S. Bureau of Standards in determining the wearing quality of flooring materials were described by D. W. Kessler. The Dorry apparatus was not found suitable, especially for the harder materials, and a new apparatus was devised. It consists essentially in a revolving cast-iron disk upon which test specimens are exposed to the action of dry abrasive material. Excellent comparative results were obtained, but in the discussion which followed the presentation of the paper the author stated, when asked whether the results could be correlated with service, that service conditions vary so widely that no such relationship can be set up. Further discussion brought out the fact that the service life of flooring materials also depends upon the character of cleaning compounds used and methods of cleaning. Slipperiness also was stated to be an important factor in the service life of a floor. At the present time the Bureau of Standards is making tests relating to that condition.

New Officers—Dr. G. W. Thompson, chief chemist of the National Lead Company, New York, was elected to succeed Professor Moore as president of the society. K. G. Mackenzie, of the Texas Company, New York, was elected vice-president. New members of the executive committee are: Prof. T. R. Lawson, of Rensselaer Polytechnic Institute; H. S. Mattimore, of the Pennsylvania Highway Department; Dr. P. D. Merica, of the International Nickel Company, and S. T. Wagner, of the Reading Company.

Erecting a Large Steel Arch Bridge in England

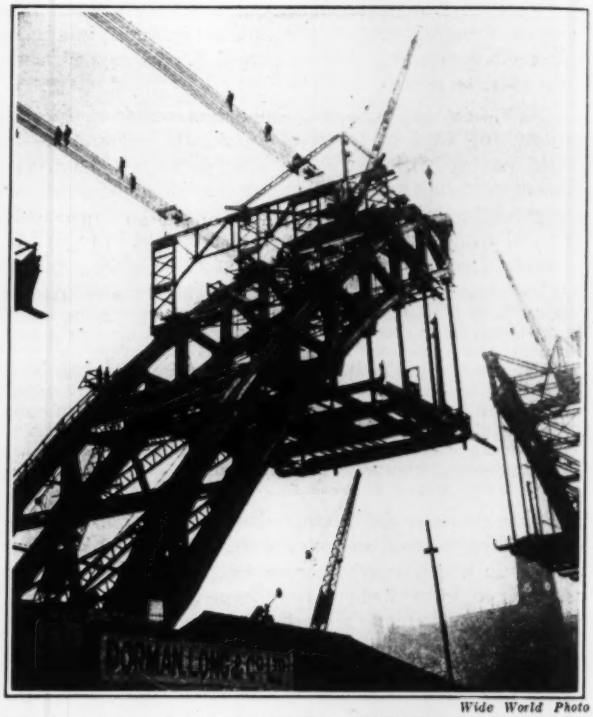
Arch With 531-Ft. Span and 84-Ft. Clearance Joins Newcastle and Gateshead, England— Total Length of Bridge Is 1,851 Ft.

A STEEL ARCH highway bridge of both technical and economic significance is being erected over the Tyne River between Newcastle and Gateshead, England. Begun three years ago, it is expected to be completed in the fall of 1928. The steel arch is of the two-hinged type with 531-ft. span and a 170-ft. rise and gives a shipway clearance of 84 ft. between mean high water and the suspended roadway. Each arch rib consists of an upper and a lower chord connected by Warren-type bracing, the spread between chords at the center being 20 ft. 3 in. It is said to be the largest steel arch yet built in England.

Steel and masonry approaches totaling 1,320 ft. carry the roadway over the sloping river bank and low-lying contiguous territory. Between the last bent of the approach and the part of the roadway suspended from the arch the roadway is supported on columns carried by the top chord of the arch. The roadway is 38 ft. wide, and provision is made for 9-ft. sidewalks on either side. The cost of the bridge will be about $6,250,000.

Apart from the railroad bridges, there have been only two crossings between Newcastle and Gateshead. One of these is a low-level swing bridge (shown in Fig. 1), whose service is frequently interrupted by river traffic. Upstream from the low-level bridge is a high-level toll bridge, carrying street cars and one line of vehicular traffic each way. The new bridge will also carry street cars, but will provide for two lines of traffic each way.

The foundations for the arch abutments were sunk 70 ft. to rock with compressed-air caissons. The steel bents of the approach spans rest on 20-ft. diameter concrete shafts supported on clay.



Wide World Photo

FIG. 2—ERECTING 531-FT. STEEL ARCH HIGHWAY BRIDGE OVER TYNE RIVER, ENGLAND

The erection of the main arch began in August, 1927, and final closure was made in April, 1928. The method of erection is shown in Fig. 2. Operations proceeded from both ends. The first six panels of each rib were supported by falsework, but as erection proceeded the weight of the ribs was transferred from the falsework

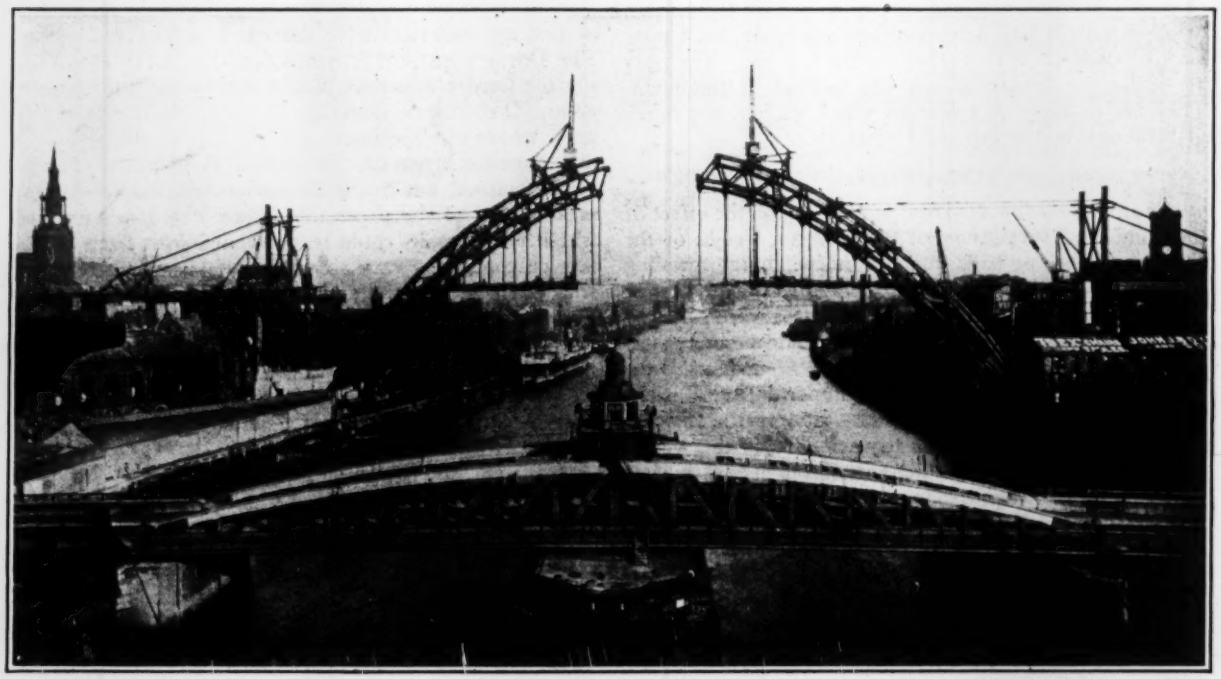


FIG. 1—THE STEEL ARCH HIGHWAY BRIDGE OVER THE TYNE RIVER BETWEEN NEWCASTLE AND GATESHEAD, ENGLAND

to cables connected to the top chord and carried back over temporary cable bents to an anchorage in the web of one of the approach spans. The cable attachment to the top chord was raised from panel point to panel point as the rib was erected, until the connection point was at the same level as the top of the temporary bents. Two stiff-leg derricks were used on the ribs, each successively dismantling the other and moving it ahead as erection progressed.

Final closure was made by temporarily inserting a pin in the top chord by easing the cables until the two halves of the arch met. Then by means of hydraulic jacks the center section of the lower chord was fitted into place. The fabrication and erection of the steel was carried out by the contractors, Dorman, Long & Company, Ltd., Middlesbrough.

Appraisal of Benefits of Water Supply for Youngstown and Niles

BENEFITS from the works projected by the Mahoning Valley Sanitary District for a new water supply for Youngstown and Niles, Ohio, and the division of the benefits between the two cities have been determined by a board of appraisers and its findings have been confirmed by the court of jurisdiction. This action gives the directors of the district authority to finance the project (see *Engineering News-Record*, Jan. 12, 1928, p. 91) by levying assessments and issuing bonds. The method followed by the appraisers and the resulting figures have been summarized for *Engineering News-Record* by W. H. Dittoe, chief engineer of the district, as follows:

The appraisers set out a total benefit of $5 per capita per year for a 25-year period, 1930 to 1955, corresponding approximately with the period of payment of the assessment upon the two cities. This per-capita rate was applied to the estimated total populations of the two cities for the period mentioned. The actual annual benefit so calculated was brought back to 1930 value, using an interest rate of 4 per cent compounded and resulting in a total benefit for the period mentioned of $21,534,000. This total benefit is comparable to the estimated cost of execution of the "official plan," $9,150,000. The latter sum does not include interest charges during construction.

The total benefit of $5 per capita per year was made up of benefits of two kinds—namely, a specific benefit of $2.50 per capita per year and a general benefit of the same amount. The specific benefit is represented by actual money savings due to a better quality of water, chemically, as follows: Soap savings by reduction of hardness of 80 p.p.m., $0.58; saving of plumbing upkeep, $1.82 ($10 per dwelling per year); reduced depreciation of fabrics in the laundry, saving of heat losses, etc., lumped at $0.10 per capita per year.

The general benefit represented "by improved conditions affecting public health, safety, comfort, convenience and welfare, encouraging general increase in property values and permitting growth and prosperity, which will result from the provision of a satisfactory water supply and improved fire protection," was fixed at $2.50 per capita per year, it being the judgment of the board of appraisers that the general benefit would be at least equal to that of the specific benefit of actual cash savings.

The apportionment of the total benefit to the two cities was arrived at as follows: The total benefit of $21,534,000 was divided into two parts termed respectively joint benefit and special benefit. All works and improvements for joint use were considered to confer joint benefit and all works for individual use of each city were considered to confer special benefit. The respective values of the joint benefit and the special benefit were determined to be in the same ratio as the estimated costs of works for joint and individual use respectively. The joint benefit was thus determined to be $14,337,300 and the special benefit $7,196,700. The joint benefit was apportioned by using the factors of population and tax valuation, giving equal weight to each of these factors. The most recent official records of population and tax valuation were employed for this purpose. The special benefit to each city was apportioned by employing the ratio of the estimated costs of those portions of the improvement provided for the individual use of each city. The summation of benefits thus calculated showed benefit to Youngstown of $19,499,100 and benefit to Niles of $2,034,900, being 90.55 per cent and 9.45 per cent of the total benefit. The percentages applied to the estimated cost of the project, $9,150,000, give tentative costs to Youngstown and Niles of $8,285,125 and $864,875 respectively.

The appraisers recommended that subsequent appraisals of benefit be made at ten-year intervals, beginning in 1930, in order to take into account the actual costs instead of the estimated costs and also to take into account possible changes in population and tax valuation relationships during the period of payment of assessments.

To raise funds for construction, the district will issue bonds not exceeding 90 per cent of the amount of the total assessment. Annual levies will be made, proportioned to the benefits, to raise funds to meet yearly interest and bond redemption dues. The annual levy is to be paid by each city at tax collection periods and the law permits the city to collect for this purpose a special tax levy exempted from statutory limitations. Interest on bonds during the construction period is to be paid from the proceeds of annual levies.

Output of Masonry, Natural and Puzzolan Cements Increased in 1927

Statistics of hydraulic cements, other than portland cement, in 1927, which include masonry, natural and puzzolan cements, as compiled by the U. S. Bureau of Mines, show that the nation's production—2,123,868 bbl.—exceeded that of 1926 by about 1 per cent. Shipments of these cements from mills in 1927 increased more than 6 per cent in quantity and more than 2 per cent in gross value. Stocks at the mills decreased and were about 19 per cent lower at the end of 1927 than at the end of 1926.

MASONRY, NATURAL, AND PUZZOLAN CEMENTS PRODUCED, SHIPPED AND IN STOCK IN THE U. S., 1926 AND 1927

Year	Active Plants	Production, Bbl.	Shipments— Bbl.	Shipments— Value	Stock (Dec. 31), Bbl.
1926	11	2,104,891	2,031,851	$2,820,110	181,928
1927	11	2,123,868	2,158,323	2,881,029	147,473

These statistics represent the output of eleven plants, which are located as follows: One each in the states of Alabama, Illinois, Indiana, Kansas, Kentucky, Ohio and Pennsylvania; and two each in the states of Minnesota and New York.

The output has been expressed in terms of 376-lb. barrels to correspond with the statistics of portland cement.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Eccentric Loads on Columns

Sir—W. C. Spiker does well to call attention, in *Engineering News-Record*, May 3, 1928, p. 708, to an error which appears in the Carnegie Pocket Companion, in Kidder and Nolan and in Hool and Johnson's Handbook of Building Construction.

The question is that of designing a simply supported column of length l which carries an axial load P_1 and in addition a load P applied with an eccentricity x at some point between the ends of the column as shown in the accompanying diagram. If l_1 and l_2 denote the distances of this point from the top and the bottom of the column respectively, the maximum moment, due to P, in the column above the point of application of P is approximately Pxl_1/l, and the maximum moment below the point of application of P is approximately Pxl_2/l. The explanation of these approximations is given in Modern Framed Structures, by Johnson, Bryan, and Turneaure, Part III, Arts. 63 and 70. It is clear that the maximum moment in the column, due to P, can become equal to Px only when l_1 or l_2 equals l—that is, when the load P is applied eccentrically either at the top of the column or at the bottom. But there is another objection to the method of design as given in the handbooks mentioned, and also as specified in the A.R.E.A. General Specifications for Steel Railway Bridges. The method assumes that the strength of a column is measured directly by the maximum fiber stress in the column, whereas, in general, the maximum fiber stress is not a measure of the strength. A preferable method of design is indicated by Johnson, Bryan and Turneaure and is discussed by E. W. Rettger in *Engineering News-Record*, Oct. 23, 1926, p. 662. By this method, for the case $l_1 = 0$, $l_2 = l$, the required cross-sectional area A of the column is obtained by the formula, $A = (P_1 + P)/f_c + Pxc/f_b r^2$, where f_c is the allowable average stress obtained from the column formula being used, c is the distance (measured in the plane of the couple Px) from the gravity axis of the cross-section to the extreme fiber in compression, f_b is the allowable flexural stress, and r is the radius of gyration of the cross-section in the plane of the couple Px.

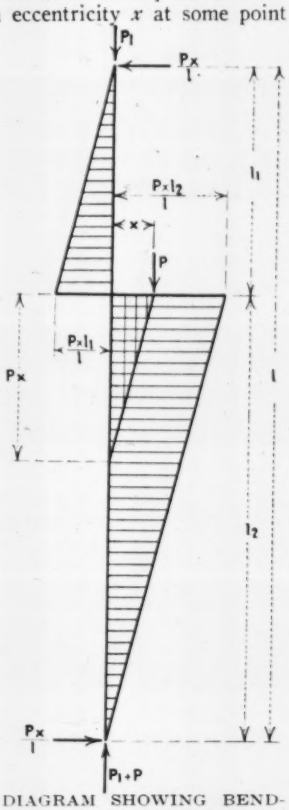


DIAGRAM SHOWING BENDING MOMENTS IN COLUMN AND BRACKET

The writer would suggest extending this method to the case where l_1 is not equal to 0 and l_2 is not equal to 0, by writing for A, $A = P_1/f_c + P/f_{c_2} + (Pxl'c \div l)/f_b r^2$, where f_{c_2} is the allowable average stress obtained from the column formula for a column of length l, and l' is the larger of the two values, l_1 and l_2.

WILLIAM R. OSGOOD,
Assistant Professor of Structural Engineering,
Cornell University.

Ithaca, N. Y.
May 19, 1928.

A Question in Financing Water Service Connections and Meters

Sir—Prior to the creation of the various state public service commissions it was the general practice for the consumers taking service from water utilities to pay for the service lines from the main to the curb and for the meter. This is still the practice of many municipal water departments. The public service commissions, however, with the approval of the courts in practically all of the states, have decided that water companies should furnish the service line from main to curb and the water meter without cost to the consumer. This means that there must be an investment of from $25,000 to $50,000 or more for each thousand consumers supplied, which is a very considerable part of the investment in plant. Every water utility has a certain number of non-active taps due to properties that are not occupied, people who are on vacation in the summer, or in Florida or California in the winter, and the number of properties not taking service may range from 2 to possibly as high as 5 per cent of the total number of taps. Thus a considerable investment is not producing any revenue and under the present methods of rate making must be carried by those consumers taking service.

In these days of the careful segregation of costs of service and the equally careful effort to apportion those costs to the persons receiving benefits through service rendered, the question has been raised as to whether or not there should be a portion of the service charge, minimum rate, flat rate, or whatever the basis of charge may be, that shall be charged against properties in which the water utility has an investment in service line or meter, or both, which are not taking service. The public service commissions were very quick to place the burden of investment in service lines and meters upon the water company, but as yet, so far as the writer knows, there has been no rate schedule made which takes into account any specific return upon the investment in such unused facilities. Perhaps some of your readers may know of cases where such rates have been fixed or approved. If so, I should be very glad to learn of them.

The argument may be made that if a water utility is earning a reasonable return upon its investment, including that in service lines and meters, it makes little difference to it where the money comes from, and further that there would be difficulty in collecting rates assessed upon properties that were not taking service—that is, where the water supply had been shut off. However, in some of the summer resorts where service is given only during the summer months it has been customary to collect a portion, in most cases half, of the minimum rate, while the property was vacant and no service taken. In the case of a service charge it would seem as though the whole amount should be charged.

This matter was referred to a committee of the Pennsylvania Water Works Association at its convention last October. I shall be very glad to receive, either through your columns or by letter, any information on or discussion of this subject.

W. C. HAWLEY,
Chief Engineer and General Superintendent,
Pennsylvania Water Company.

Wilkinsburg, Pa.,
July 2, 1928.

First Coast-to-Coast Highway in Philippines

Construction of its first coast-to-coast highway is expected to be started soon in the Island of Mindanao, Philippines. The road will be 125 miles long. The new highway will run through the heart of the island from the Province of Davao to that of Lanao. It will connect Illana Bay on the west coast of the island with Davao Gulf on the southeast, passing through rich agricultural regions that are expected to be opened to settlement as soon as the road is finished. Two other roads are planned to connect the provinces of Surigao and Augusan in the northeast of the island and the provinces of Lanao and Cotabata in the south. Each of these roads will be about 60 miles long. Cost of the three proposed roads is placed at somewhat less than 5,000,000 pesos ($2,500,000).

News of the Week

Current Events in the Civil Engineering and Contracting Fields

S.P.E.E. Convention Holds Annual Meeting At Chapel Hill, N. C.

Report of Board on Investigation and Co-ordination Featured—Next Meet at Ohio State

THE Society for the Promotion of Engineering Education held its 36th annual meeting June 26, 27 and 28 at the University of North Carolina. In the registration of over 350, the largest in the history of the society, nearly every technical school in the country was represented. The original four-day program was shortened to three days, crowding out several papers of promising interest. The report of the board of investigation and co-ordination received much prominence. Charged with the responsibility of keeping engineering education apace with industrial advancement, this committee is doing some of the most important work in the society. A critical appraisal of engineering education in the United States was followed by recommendations of future organization and activity.

SUMMER SCHOOLS FOR TEACHERS

Much interest was manifested in the report of the success of the special summer school sessions inaugurated last year for engineering teachers. Similar sessions are now under way at Massachusetts Institute of Technology and the University of Pittsburgh. Plans for next year concentrate on a single session devoted to one of the major divisions of the curriculum. As a further incentive for attending the summer school, efforts are being made to secure allied courses running concurrently with the S.P.E.E. sessions for which academic credit will be given by the university acting as host.

A feature of the meeting was a paper by R. I. Rees, American Telephone & Telegraph Company, on "College Experience in Its Relation to Achievement in Industry." By the use of charts, Mr. Rees showed a striking comparison between the advance of the employees within the company and their relative academic standing in school. Extra-curricular activities also made a favorable impression on the charts. This upsets the somewhat popular belief that academic standing and outside activities have no bearing on a career after leaving school.

The entire conference was guest of Duke University one evening, being shown the new $20,000,000 development of an entirely new campus in an estate of 5,000 acres. Group conferences on teaching problems and the annual banquet completed the meetings at Chapel Hill. The closing sessions were held at North Carolina State College at Raleigh, followed by a barbecue at the Cape Fear plant of the Carolina Power Company.

Ohio State University, at Columbus, Ohio, was selected for next year's meeting. The new officers are: President, Dean Dexter S. Kimball, Cornell; vice-presidents, Dean C. C. Williams, University of Iowa, and Dean G. M. Braune, University of North Carolina; secretary, F. L. Bishop, University of Pittsburgh; treasurer, W. O. Wiley, John Wiley & Sons.

Moffat Tunnel Bonds Contested

A suit has been brought by a number of Colorado taxpayers against the Moffat Tunnel Commission requesting the cancellation of $8,750,000 in bonds issued by the commission. The tunnel commission was originally authorized by the taxpayers to issue $6,720,000 in bonds. As additional funds were needed, the commission later issued additional bonds without again going to the voters for authority. It is the latter which are now being contested.

The suit follows the announcement of the commission that $516,200 would be collected this year as a special tax to pay interest on the bonds. It is claimed that the only notice the public had of the extra bond issues came when the newspapers mentioned that the bonds had been issued and sold.

Baltimore Water-Works to Be Enlarged and Improved

From the proceeds of the recent $10,000,000 water loan, the city of Baltimore will proceed with the immediate expenditure of $6,507,000 on a program of extensions and improvements. The principal items will be a series of major mains of an aggregate cost of slightly more than $1,100,000, a series of small extension mains at an estimated outlay of $1,750,000 and a feeder main from the new Montebello filtration plant to Druid Lake, costing approximately $1,000,000. Other items will include an expenditure of $625,000 to adapt the Mount Royal pumping station to changed operating conditions and to build new mains in connection with this station. Provision is made for an expense of $150,000 in removing the Pikesville pumping outfit from Druid Hill Park to Ashburton, farther from the center of the city, and for an item of $70,000 in addition to allotments already made for the Curtis Bay reservoir and pump.

Thompson Elected President of A.S.T.M.

The presidency of the American Society for Testing Materials for 1928-29 went to Gustave Whyte Thompson, chief chemist of the National Lead Company since its organization in 1892. It has been said that much of the prosperous history and present enviable position of the National Lead Company is due to Dr. Thompson's efforts. A quite similar statement would apply to his activities in the A.S.T.M.

Besides his connection with the National Lead Company, Dr. Thompson is an officer and director in numerous other companies. His principal investigations in the field of research have been on lead pigments; mixed paints; smelting and refining of metals; recovery of secondary metals; mixing and refining of alloys; titanium oxide pigment; and the smelting and refining of tin.

American Chemical Society, the Society

Dr. Thompson is a member of the of Chemical Industries, the American Institute of Chemical Engineers (president, 1918), the A.S.T.M. (vice-president, 1926), the Chemists Club and the Metal and Rubber Club of New York.

New York City Constructors to Wage Safety Campaign

An intensive campaign to lessen the suffering and economic loss caused by accidents in construction work has been inaugurated by the Building Trades Employers' Association of the city of New York. An annual appropriation of $15,000 will be expended under the direction of committee composed of H. W. Lohmann, vice-president, James Stewart & Company, chairman; D. H. Dixon, vice-president, Turner Construction Company, vice-chairman; Max Baumann, president, George S. Holmes Company, Inc.; Samuel B. Donnelly, chairman of the board of control of the Allied Building Metals Industries; John Lowry, president, John Lowry, Inc.; Frank B. Rogers, construction superintendent, Fred T. Ley & Company, Inc.; and J. E. Rutzler, president, E. Rutzler Company. William G. Wheeler, safety expert, has been made executive secretary.

Allegheny County Approves Large Bond Issue

At a special election held June 26, the voters of Allegheny County, Pennsylvania, approved a proposed bond issue of $43,680,000 by an average majority of about 2 to 1. A number of improvements are thus made possible, among them a new airport, a municipal auditorium, park and public building improvements and boulevard extensions. Work on some of the projects will be started as soon as the bonds can be advertised and sold, but the entire program will not be complete for more than four years.

Wanaque Aqueduct Work Taken From Engineering Staff Again

Subject to the provisos noted below, "the design and construction of the Wanaque aqueduct, to convey water from the Wanaque reservoir to Paterson, Newark and six other New Jersey cities and towns," is to be put "in full charge and control" of Fuller & McClintock, New York City. Action to that effect was taken on June 28 by the unanimous vote of the four members of the North Jersey District Water Supply Commission. The provisos are: (1) That a satisfactory agreement can be reached on compensation; (2) that the "contracting municipalities execute the supplemental contracts heretofore submitted to them for the completion of the work"—meaning, in effect, that the eight cities and towns agree to provide funds in addition to those already authorized.

The design of the Wanaque aqueduct has been the subject of much controversy for some two years past. The present action, if consummated, will be the second time the work has been taken away from the commission's staff engineers and put in the hands of consulting engineers in New York City. First it was turned over to Col. George A. Johnson, with instructions to change the plans so as to provide an all-pressure steel instead of a part-length gravity concrete aqueduct, with steel the remaining distance. Subsequently the commission terminated the services of Colonel Johnson. Second, a few months ago, Fuller & McClintock were engaged by Paterson, Passaic and Clifton to report on the advisability of doing away with the aerator proposed by the staff engineers and advised against by Colonel Johnson in order to utilize the entire head of the water stored in the reservoir. A semi-compromise plan was proposed by Fuller & McClintock, calling for both the aerator and the utilization of the full head of the reservoir, but with pumping to the aerator during the relatively small part of the year when, in the opinion of these engineers, aeration would be needed. (See *Engineering News-Record*, April 26, May 3 and May 10, 1928, pp. 678, 711 and 757.) Kearny joined with Paterson, Passaic and Clifton in advocating this change in plan, and the four communities also advocated the engagement of Fuller & McClintock to take charge of the aqueduct work.

Arthur H. Pratt has been chief engineer and Morris R. Sherrerd consulting engineer of the North Jersey District Water Supply Commission since the inception of the reservoir and aqueduct project.

Railroad Asks Relief From Safety Orders

A brief recently filed with the Interstate Commerce Commission by the Chicago, Burlington & Quincy Railroad urges that body not to require the railroad to make further installation of automatic train control or automatic block signals, on the ground that further effort toward standarization and interchangeability of the devices used should be made at this time before expending additional funds where early obsolescence seems inevitable. It is also maintained that this money can be used in other safety measures with a greater return. This is in line with similar pleas made recently by other railroads.

Engineers to Build Sewers in South America

Three American engineers have gone to Colombia, South America, to design and supervise the construction of a sewerage system for Barranquilla, a city of 100,000 population, which at present has no sewers. The engineer in charge is J. G. Melluish, consulting engineer, Chicago, recently with Pearse, Greeley & Hansen, and for many years city engineer of Bloomington, Ill. Charles H. Wuchter, formerly assistant engineer for the late R. W. Pratt, is principal assistant engineer. William T. Nelson, with extensive experience in this country and in South and Central America, is assistant engineer, with special charge of field work. They will work under the direction of Parrish & Company, Barranquilla, who have the concession and construction contract for the sewerage system.

Delegates to Housing and Town Planning Congress Named

The Department of Commerce will be represented by five voluntary delegates at the International Housing and Town Planning Congress, to be held in Paris July 2 to 8. The Congress is one of several gatherings to be held in Paris in July, and has been arranged by the International Federation for Housing and Town Planning, with which several American organizations, including the City Planning Division of the American Society of Civil Engineers, the National Conference on City Planning and the National Housing Association, are affiliated. The five men appointed are:

Alfred Bettman, Cincinnati, Ohio, of the advisory committee on city planning and zoning of the U. S. Department of Commerce; Harold S. Buttenheim, New York, chairman of the American committee of the Congress; George B. Ford, New York, president of the Federated Societies on Planning and Parks; John Nolen, Cambridge, Mass., former president of the National Conference on City Planning; and Robert Whitten, New York, city planner, Regional Plan of New York and Its Environs.

The principles upon which zoning ordinances are based and the laying out of street systems to handle the ever-growing volume of motor traffic are among the problems confronting American cities which will come up for discussion by authorities from the United States and abroad.

Two Old Buildings Collapse Suddenly in New Orleans

The collapse on June 23, without warning, of two old buildings on Bienville St., New Orleans, was fortunately not accompanied by fatalities. The buildings were both of brick construction, with lime mortar joints and wooden beams. Cast-iron columns on the street front supported the door and window lintels. The buildings may have been built before the American occupation, and at any rate were nearly 100 years old. They were originally designed for occupancy of stores on the first floor, with residences on the second and third floors. At the time of the collapse one of the buildings was vacant and the other was used for the storage of leather goods and raw leather.

Arthur M. Shaw, consulting engineer, New Orleans, reports that the building department of the city has not determined the cause of collapse. Mr. Shaw has sent the following information to *Engineering News-Record:*

"Eyewitnesses state that the collapse of the two buildings was practically instantaneous. Each building had about a 30-ft. frontage on Bienville St. and was about 80 ft. deep. I have been unable to locate anything concerning the loading imposed on the floors, although it seems to be the impression that the second and third floors of the occupied building were excessively overloaded. One theory advanced by non-technical observers is that the collapse was caused by such overloading, the failure of the floors causing a bulging of the walls toward the unoccupied building and consequent toppling over of the party wall and the outside wall of the latter structure. The position of the wreckage is such as to appear consistent with this theory. The party wall and the side walls of both buildings were 16 in. thick to the top of the first story and then 12 in. to the roof. Both brick and mortar in the walls appear to be in as good condition as ordinarily found in such buildings. Under the local "ratproofing" ordinance, the first floors had been renewed by placing cement floors directly on the ground. Aside from this, there can be found no record of any recent reconstruction work having been done in either building."

Annual Convention of Am.Soc.C.E. in Buffalo in July

The 58th annual convention of the American Society of Civil Engineers will be held in Buffalo July 17-20, 1928. The first day of the meeting will be devoted to a conference of local section representatives. Automobile drives and other entertainment will be provided for the ladies. Friday will be devoted to an all-day trip to Niagara Falls.

The technical session on July 18 will hear two papers, "The Engineering Pioneers of the Niagara Frontier," by Walter McCulloh, consulting engineer, Niargara Falls, N. Y., and the "Interim Report of the Special International Niagara Board on the Preservation of Niagara Falls," by Robert S. Thomas, major, Corps of Engineers, U. S. A., district engineer, Buffalo, N. Y. The sanitary engineering division on Thursday will be devoted to a symposium on "The Sanitary Character of the Waters of Lake Erie and the Niagara River" and to a paper entitled "Refuse and Garbage Disposal on the European Continent: A Description of Several Incinerating and Becarri Plants," by Francis L. Pruyn, vice-president, American Becarri Corporation, New York City. The paper before the power division on Thursday will be entitled "Niagara Power," by N. R. Gibson, chief engineer, the Niagara Falls Power Company, Niagara Falls, N. Y. On Thursday also the waterways division will listen to a paper entitled "Regulation of Levels, Flow and Navigation on the Great Lakes," by George B. Pillsbury, lieutenant colonel, Corps of Engineers, U. S. A., Philadelphia, Pa.

North Carolina Engineers Hold Summer Meeting

The annual joint summer convention of the North Carolina Society of Engineers and the North Carolina Branch of the American Society of Civil Engineers was held at Wrightsville Beach, N. C., on June 22 and 23. A feature of the convention was the discussion of airports and their development, and the society put itself on record as urging prompt development in this direction in North Carolina. T. C. Atwood of Durham was appointed delegate to attend the convention of the Society for the Promotion of Engineering Education at Chapel Hill, N. C.

Many interesting papers were read. These included the following: Reforestation, by Reuben Robertson, president, Champion Fibre Company; Incomes of North Carolina Engineers, by P. H. Daggett, secretary, State Board of Registration for Engineers and Land Surveyors; Concrete Piles and Concrete Slabs, by D. B. Packard, engineer of construction, Atlantic Coast Line Railroad; Recent Developments in Sewage-Treatment Practice, by G. F. Catlett, principal assistant engineer, State Board of Health, and Engineering Education, by C. S. Coler, educational director, Westinghouse company.

Washington Notes

By Paul Wooton
Washington Correspondent

Private Toll Bridges Scored—Contractors Criticise Levee Work—Building Demolition

AN INVESTIGATION by the committee on roads of the House of Representatives of the toll bridge question is being agitated by Representative Cochran, of Missouri. He hopes to arouse enough interest in the matter among members of the House during the interval between sessions to assure a favorable vote on such a proposition shortly after the convening of the December session. He believes that such an investigation will show that privately owned toll bridges are earning as high as 50 per cent on the actual investment. As 235 bridge bills were passed at the last session of Congress, Mr. Cochran is convinced that the full facts must be revealed or the privately owned toll bridge soon will be almost as conspicuous on the federal-aid highways as were the toll gates on the improved roads of a generation ago.

The Bureau of Public Roads recently made a toll bridge survey, but it was found that both federal and state officials frequently were denied information relative to the cost of construction, the amount of securities issued and the amount of revenue collected. It was found, however, that on Oct. 1, 1927, there were 233 toll bridges in operation on the highways of the United States, of which 82 per cent were privately owned. In addition, 29 were under construction, of which 69 per cent were privately owned.

The bureau points out that private toll bridges are dependent for their income upon traffic flowing to them over highways built with public funds. It cites outstanding examples of obstructionist tactics on the part of private toll bridge interests to prevent the building of free bridges or the securing of legislation by the state to that end. Attention is called to the fact that where the necessary capital is not available for free bridges, the public can secure advantageous loans from the best banking houses by issuing revenue bonds, which do not constitute a debt, in the constitutional sense, against the community. Under the Oldfield amendment to the highway act federal aid is available for bridge construction. The amount supplied by the state can be retired through the collection of tolls. Officials of the bureau doubt if there is any instance where a private toll bridge is desirable, or where its construction is sound as a public policy.

Charge Unfairness on Levee Work

Unfair tactics are being used in the handling of levee work on the Mississippi River, in the opinion of Col. D. H. Sawyer, secretary, A.G.C., who has just returned from a conference at Memphis with levee contractors. The government has reserved for its day-labor operations the more favorable sectors of levee and has called for bids covering the sectors where the work is more difficult. An effort was made to call this situation to the attention of the Board of Three at its Memphis hearing, but General Jadwin ruled against the consideration of that question, as it did not come within the jurisdiction of the board. A brief on the subject, however, was filed with General Jadwin in his capacity as Chief of Engineers. In the brief it is contended that the government elects to do the more desirable work with its own forces, and as a result those operations do not furnish an accurate index of cost on various types of work. The brief deals with all phases of the current situation and presents arguments for adherence to competitive contracts.

Power Commission Employees

The fact that the Federal Power Commission has been authorized to pay from its own appropriation "the salaries of all civilian employees whose service with the commission has become permanent through detail from any executive department" does not relieve the War, Interior and Agricultural departments from the responsibility of performing any necessary work which has been performed by those departments in the past, the Comptroller General has ruled. There is a feeling in the departments that the intent of Congress in allowing the commission to pay directly the staff it has been employing was to preclude further drafts upon the departments for clerical help. There also is a feeling that there is a tendency on the part of the commission's staff to take over work that Congress intended the departments themselves to do and which some believe they could do effectively and economically. It is expected that the matter will be brought before the Comptroller General again before further employees are loaned to the Power Commission.

Demolition Inspection

Criticism by the Bureau of Efficiency of the building inspector for the District of Columbia has grown out of two recent accidents in connection with razing operations. Several workmen were injured as a result of the unexpected collapse of parts of structures being torn down. The building inspector in this connection declares that it requires more technical skill to tear down a building than it does to erect one. Because of the character of the work, he says, no adequate inspection can be maintained unless an inspector is kept on the job continuously. He is in favor of an amendment to the code which would require razing contractors to pay the salaries of the inspectors necessary. He criticises contractors for not assigning more capable men to their razing jobs.

Returns on a questionnaire sent out by the housing division of the Bureau of Foreign and Domestic Commerce to secure information as to building codes

indicate that adequate provision has not been made for the inspection of razing operations outside of a few large centers. Apparently building inspectors pay little attention to that type of work. Because of the very great increase in the number of buildings being razed, even in the smaller towns, the question of adequate inspection is becoming one that must be reckoned with, officials at the Department of Commerce point out.

Want Rivers Improved

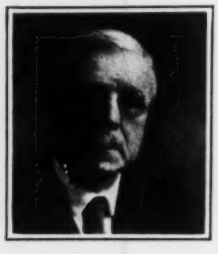
Pacific Coast interests were represented at each of the national conventions for the purpose of stimulating interest in river and harbor development in that area. It was pointed out that expenditures for river and harbor work in the Pacific Coast states are less than 9 per cent of the total expenditures for such purposes. Of the total sum expended by the government prior to June 30, 1927, on river and harbor works, 27.45 per cent has gone to projects on the Atlantic coast; 13.12 per cent to those in the Gulf area; 35.68 per cent on the Mississippi River and its tributaries; and 14.77 per cent to projects on the Great Lakes. It was argued that a larger proportion of river and harbor appropriations should be allocated to Western rivers, particularly since the large untaxable holdings of the government would benefit greatly.

Aroused by Brick Imports

The importation last year of 110,000,000 bricks at the port of New York alone has aroused the domestic industry, which is demanding relief in the form of a duty on imports. At present building brick is on the free list. Protests reaching Washington have been answered to the effect that a revision of the tariff must be awaited before an effort can be made to secure the relief asked. While the President may increase or lower the rates of duty, he is given no authority over the free list under the flexible provisions of the act.

J. B. Berry, Railroad Engineer, Dies

John B. Berry, railroad engineer of long experience and a former chief engineer of the Union Pacific Railway and the Chicago, Rock Island & Pacific Railway, died at Three Lakes, Wis., on June 23. He was born in 1852, and from 1873 to 1897 was connected in various capacities with the Chicago & Northwestern Railway system; from 1893 to 1897 he was chief engineer of its lines west of the Missouri River, then known as the Fremont, Elkhorn & Missouri Valley Railway. In 1897 he was appointed chief engineer of the Union Pacific Railway and had charge of the extensive improvements carried out in grade reduction, double tracking and bridge reconstruction for heavier engines, in view of the increasing traffic and the desirability of handling heavy trains at higher speeds. In 1903 he was made chief engineer of the Chicago, Rock Island & Pacific Railway, to plan a similar improvement program, and in 1913 he was appointed assistant to the president of the road. In 1914 he took up private practice and opened an office in Chicago, but gave this up about 1917. In 1920 he was consulting engineer for the Grand Trunk Railway, again in connection with a program for important improvements. For the past few years he had retired and had suffered from long spells of ill health. Mr. Berry was a charter member of the American Railway Engineering Association, and for some years was active in its affairs. He was a director from 1911 to 1913, chairman of the grading (now roadway) committee, 1900 to 1904; and a member of the rail committee from 1908 to 1916.



Brief News

FLOODING OF MORE THAN HALF A MILLION ACRES of lowlands in Arkansas has resulted from heavy rains and levee breaks along the White, Cache, Black, St. Francis and Little Red rivers. It is stated that more than 500 families had been driven from their homes.

CHICAGO BOND ISSUES of $15,500,000 for the construction of island park property and a boulevard connection with the Lincoln Park system, the completion of the Soldier Field stadium and other park improvements were approved by the voters. The bond issues provide for the immediate construction of three islands in Lake Michigan, proposed as a site for Chicago's World Fair in 1933.

A CLOUDBURST in Callaway County, Missouri, in the Ozark Mountains, washed out about 6 miles of track of the Missouri Pacific Railway and did extensive damage to highways, telephone lines and crops. No loss of lives was reported.

A NEW BRIDGE, known as the Austin Peay bridge, has been opened across the Cumberland River at Gainsboro, Tenn. It consists of three steel spans, has a total length of one-third of a mile and cost approximately $220,000.

WORK HAS BEEN STARTED on the new Internal Revenue Building in Washington, to cost approximately $10,000,000. Excavation has been begun for the foundation, and piles are being driven. Plans call for 8,000 concrete piles, which are expected to be in place within 100 days of the start of construction.

CONSTRUCTION OF A DAM and large power plant with a storage capacity of about 25,000 hp. on the Bow River, in the Province of Alberta, near the intersection of the Ghost River, will be commenced as quickly as plans can be completed and the contract awarded, according to announcement made by G. A. Gaherty, head of the Calgary Power Company. The decision resulted from ratification by the city council of Calgary of a ten-year contract submitted by the power company. The cost of the work will be approximately $2,500,000.

Random Lines

Mellow With Age

Our fellow engineers in Great Britain have just been celebrating the centenary of the founding of the Institution of Civil Engineers. For those who having read the report of that celebration as published elsewhere in this issue may feel that in the serious work of building up a great technical society too little attention was paid to the finer things

Bill of Fare

SHERRY ROYAL AMONTILLADO	Caviare Smoked Salmon.
WHITE WINE CHABLIS MOUTONNE MONOPOLE	Sturgeon Consommé. Cream Reine.
CLARET CHATEAU PONTET CANET 1917	Fillets of Sole Walewska.
BURGUNDY RICHEBOURG	Cornets of York Ham with Foie Gras.
CHAMPAGNE HEIDSIECK DRY MONOPOLE 1919	Saddle of Lamb with Mint Sauce. Jersey Beans New Potatoes.
FERRIER JOUET RESERVE CUVEE EXTRA DRY 1919	Roast Ducklings. New Peas and Salad.
PORT GONZALEZ 1900	Asparagus with Melted Butter.
BRANDY COURVOISIER 1893	Strawberries in Liqueur. Parfait Glace.
LIQUEURS	Coffee.

of life we publish the accompanying bill of fare from the banquet held during the celebration. It bespeaks a breadth of vision and mellowness which comes from a well rounded life.

* * *

The Last Word in Transits

"In just an hour or so you can make your own survey of New York City's Northern Million" says the *Home News* (Bronx) in Sales Management & Advertiser's Weekly.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS: Annual Convention, Buffalo, N. Y., July 18-20.

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; Annual Convention, Montreal, Canada, Sept. 18-21.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; Annual Convention, Detroit, Mich., Oct. 22-28.

THE NATIONAL SAFETY COUNCIL has announced the date of the Seventeenth Annual Safety Congress as Oct. 1 to 5, 1928. The congress is to be divided into a number of sectional meetings, each of which will discuss accident prevention problems in its own industry. All meetings will be held in New York City, that of the Public Utilities Section at the Pennsylvania Hotel.

Personal Notes

ROBERT S. BEIGHTLER has been appointed chief engineer and first assistant director of highways of the State of Ohio, succeeding Harry J. Kirk, who was recently made director of highways. Mr. Beightler, who entered the highway department eight years ago and has been chief engineer of construction for several years, is a graduate of Ohio State.

R. C. MOORE, colonel, Corps of Engineers, is en route to Peru, where he will act as an adviser to the Peruvian government in matters pertaining to the construction of fortifications. Col. R. R. Ralston, who has been serving as engineer of the first New York district, will succeed Colonel Moore as chief of the military division of the office of the Chief of Engineers.

HAROLD SHERBOURNE BOARDMAN, president of the University of Maine and long identified with highway activities in that state, has received the degree of Doctor of Engineering from the Rhode Island State College.

J. M. BRYANT, of the department of electrical engineering at the University of Texas, has been appointed professor of electrical engineering at the University of Minnesota, St. Paul, Minn.

LAURENCE V. FRAZIER, lieutenant colonel, Corps of Engineers, has been assigned as district engineer of Jacksonville. The place he vacates at Savannah is to be filled by Major Douglass L. Weart.

JAMES E. BARLOW, formerly city manager of Dayton, Ohio, and New London, Conn., has been made city manager of Portland, Me., and will assume his duties on July 1. Mr. Barlow is a graduate of Massachusetts Institute of Technology and has had experience on the Charles River dam in Boston, with the Metropolitan Water Supply of New York City and as principal assistant city engineer of Cincinnati.

ARTHUR RIDGWAY, chief engineer of the Denver & Rio Grande Western Railroad Company, was the principal speaker at the annual banquet of the Colorado Section of the American Society of Mechanical Engineers. His subject was: "Trend of American Development in Railway Engineering."

ROBERT HOOKE, who has served as city engineer of Chattanooga, Tenn., for the past 38 years, has announced his retirement, effective July 1. He will continue to reside in Chattanooga. The office of city engineer will be taken over by W. H. Wilson.

FRANCIS R. WELLER, after 25 years of engineering practice, has incorporated his organization, taking into the company his employees as stockholders. Mr. Weller has specialized in the design, construction and operation of public utilities. The main office of the company will remain in Washington, D. C.

E. L. MUSTARD, who for the past year has been in the employ of the Title Guaranty & Trust Company, of Chattanooga, Tenn., is now in Bedford, Ind., and is engaged in doing the drafting in connection with the property survey being made by the Indiana Limestone Company. The company intends to make a survey of all its property, and the work will probably take a year.

ERNEST C. FORTIER sailed on June 27 to Palestine, via London, to install a system of concrete piping under a maximum pumping head of 80 m. for the irrigation of citrus orchards to be planted in one of the recently organized Jewish colonies. The work is to be done by the Palestine Electric Corporation, Ltd.

WILLIAM W. PEABODY, chief engineer of the new water-supply system for the city of Providence, R. I., has been appointed division engineer of the Metropolitan District Water Supply Commission of Massachusetts. Mr. Peabody will have charge of about 13 miles of the Wachusett-Cold Brook tunnel, now under contract. The cost of the work in this division will be more than $8,000,000.

Col. EDWARD H. SCHULZ is now head of the Great Lakes Division of the U. S. Engineer Corps, succeeding Col. Spencer Cosby, now retired. Colonel Schulz was formerly in charge of the U. S. Engineers at Chicago and before that in Hawaii. He has been a member of the Mississippi River Commission and also of the Great Lakes Ship Canal Board.

WILLIAM A. HANSELL, chief of construction of the Atlanta, Ga., department of streets, was elected a director of the newly formed City Officials Division of the American Road Builders' Association at the recent convention in Washington.

Commander G. A. DUNCAN, of the Civil Engineer Corps of the United States Navy, has been appointed engineering chief of the Republic of Haiti. This is one of the positions to be filled by the United States under the treaty with Haiti. At the present time more than $2,000,000 is being spent annually on public works in the Haitian Republic. Commander Duncan will relieve Capt. F. H. Cook, who will be assigned as public works officer of the Philadelphia Navy Yard and of the Fourth Naval District.

C. H. VOTAW, Tacoma, Wash., former county engineer of Pierce County, has become superintendent of public works of Tacoma, replacing J. W. Silver.

Obituary

HEZEKIAH BISSELL, well-known railroad engineer, for many years chief of the engineering department of the Boston & Maine Railroad, died on June 24, at Pasadena, Calif. Mr. Bissell was graduated from Sheffield Scientific School of Yale University in 1861 and served in the Connecticut Volunteers during the Civil War. His early engineering experience was with the Union Pacific Railroad, whose service he entered in 1864. Within a short time he became resident engineer on construction and played an important part in the building of the Union Pacific. When the line was completed in 1869 he associated himself with the Delaware & Hudson River Railroad. Later he went to Peru and built a hundred miles of the Puno & Cuzco Railroad. He entered the service of the Eastern Railroad, now a part of the Boston & Maine, in 1878, and had remained with that system ever since. In 1909 Mr. Bissell resigned his position as chief engineer of the company, and had since been retained as consulting engineer.

ALBERT LEOPOLD GHYSENS, a Belgian engineer, who had resided in Montreal since 1895, died in that city on June 23 in his 77th year after a protracted illness. Mr. Ghysens was born in Brussels, Belgium, and received his training in the Brussels Industrial School, graduating with many honors. After filling important positions in his native country, he went to Montreal in 1895. When the plans for the construction of the Georgian Bay Canal were made, he was appointed engineer in charge. He also supervised, in the capacity of engineer, the construction of the Transcontinental Railway. For a few years following the World War, Mr. Ghysens returned to Belgium to supervise the reconstruction of the Malines Fort, destroyed by the Germans. For this work he was decorated with the title of Chevalier of the Order of Leopold by the Belgian government. Mr. Ghysens later occupied the position of chief engineer of the city of Verdun, Que., retiring in 1923. Among the organizations of which he was a member were the Engineering Institute of Canada and the Corporation of Engineers of the Province of Quebec.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Comparison of Diesel and Gas Engine Performance

By R. J. Broege
Chief Engineer, The Buda Co., Harvey, Ill.

Extract from a paper presented before the annual meeting of the Society of Automotive Engineers.

THIS paper is confined exclusively to the industrial-automotive full Diesel engine developed in 1923 and sold in Germany to the commercial trade. The American-built Diesel, with which this paper particularly deals, is built under a license and in conformity with the patents of the M.A.N. Company in Germany. It is a compressorless, solid-injection, full-Diesel engine of the four-stroke cycle type. Whereas the older Diesels have weighed as much as 75 to 100 lb. per horsepower, these new compressorless engines weigh practically the same as gasoline engines of equal horsepower.

In our work with the introduction of this new Diesel engine, one with approximately a 4½-in. bore and 7⅛-in. stroke was placed in service for several months in one of the company's 4-ton trucks (a well-known make) in the same service with its gasoline trucks. The engine, which was a 50-hp. model and weighed 1,100 lb., was placed in the

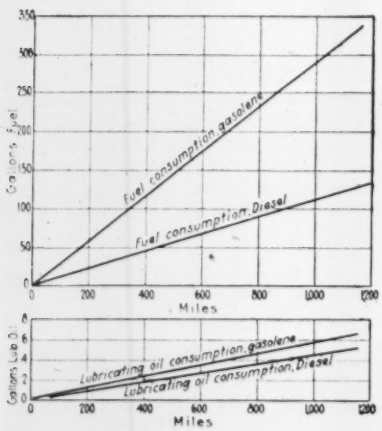


FIG. 1—SERVICE PERFORMANCE OF 4-TON TRUCKS EQUIPPED WITH DIESEL AND GASOLINE ENGINES

truck chassis without any alteration being required in the hood length or radiator.

In Fig. 1 is shown a tabulation of the service performance of this Diesel-equipped truck as compared with a gasoline engine truck. Both trucks are of the same make and capacity and no special attention was given either other than the regular periodical inspection and greasing. The gasoline engine used was a 4½-in. bore by 6-in. stroke, four-cylinder model.

Our experience showed us that the drivers learned to operate the Diesel truck just as readily and with no more effort than was required to learn to operate a gasoline truck. In addition, the driver soon discovered that the Diesel engine had far better lugging abilities than was the case with the gasoline engine truck. Contrary to general belief, the cooling of the Diesel engine was easier than that for the gasoline engine. The same radiator was

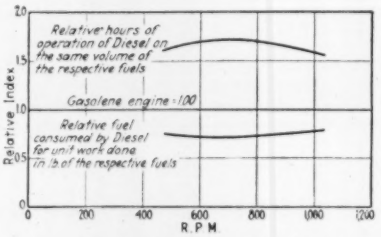

Relative hours of operation of Diesel on the same volume of the respective fuels
Gasolene engine =100
Relative fuel consumed by Diesel for unit work done in lb of the respective fuels
Relative Index
R.P.M

FIG. 2—LABORATORY PERFORMANCE OF DIESEL AND GASOLINE ENGINES

used in both cases and during the warm summer months the temperature of the Diesel engine was average. In cool weather it was found necessary to provide the radiator with a shutter in order to keep the engine up to temperature for good operation.

In Fig. 2 is shown a chart of the relative performance of a Diesel engine and gasoline engine of the same bore, both tested on the same dynamometer at the Armour Institute of Technology in Chicago. These charts indicate an operating economy of the Diesel over the gasoline engine. The economy in fuel consumption of the Diesel is not counteracted by the operating costs, since the simplicity of design and accessibility of all parts keep labor and maintenance cost at a minimum.

Tests have been conducted with several grades of fuel and in the accompanying table are given the analyses of these fuels. The engine burned each of these fuels equally well during all tests.

Fuel	No. 1	No. 2	No. 3
Baume at 60° F.	38.2	34.3	26
Carbon—Conradson test	0.006%	0.03%	2.57%
Flash—Pensky-Martin closed cup test	160° F.	225° F.	200° F.
Water and sediment	0.06%	0.10%	0.10%
B.t.u. per lb.	19,675	19,590	19,234
Sulphur	0.31%	0.63%	0.78%

The results of our tests indicate that the use of Diesel engines is possible even compared with the present heavy-duty types of gasoline engines, weight and space required being about equal.

A.G.C. Equipment Credit Plan

The recommendations set forth in the following preamble and resolutions have been adopted by the branches and chapters of the A.G.C. and are to be the basis of conferences between the contractors and manufacturers. The first conference was held in Chicago. (*Engineering News-Record*, June 28, 1928, p. 1024.)

Whereas many manufacturers and distributors of construction equipment are selling their products under credit terms which include small, if any, down payments and the payment of balances extending over period of many months, thus inducting into construction innumerable irresponsible concerns who demoralize the industry; and

Whereas those unduly extended credit terms have caused widespread overexpansion of construction companies with consequent failures and defaults, which are injurious not only to the interest of the public but also to the interests of all industries allied with construction; and

Whereas it is deemed advisable to approve the action of our branches as set forth in the resolutions adopted; and

Whereas many outstanding manufacturing equipment manufacturers and distributors recommend adherence to reasonable credit policies, including a substantial down payment and the balance within one year or less;

Now, therefore, be it resolved that this organization endeavor through conference and co-operation with construction equipment manufacturers and distributors to have them establish reasonable standard credit policies in all parts of the country; and

Be it further resolved that we encourage the members of the Associated General Contractors of America to submit to reasonable standard credit policies for sale of machinery and equipment; and

Be it further resolved that in the purchase of machinery and equipment we request our members to favor those manufacturers and distributors who establish and maintain such standard credit policies.

Cement Company Outlines Its Marketing Policies

The publication by the International Cement Corporation, New York City, and its subsidiary companies of a 38-page booklet containing a complete statement of the trade ethics and marketing policies under which Lone Star Cement is sold marks an innovation in relations between manufacturer and dealer. H. Struckmann, president of the International Cement Corporation, states that the reason for the book is that misunderstandings which grow and flourish in the dark promptly vanish when the full light of publicity is placed on them. "We have endeavored to tell how we sell our product," says Mr. Struckmann, "and how we price it, together with the basic reasons for these policies. We are willing to rest our claim to the good will of the public we serve on the facts as here presented. Our aim has been to express in the plainest possible English the rules we live by in the daily conduct of our business."

The booklet is divided into three parts: the first part is a statement of trade ethics, comprised of 31 points observed in the marketing of Lone Star

Cement; the second part of the book is an explanation of the factors and conditions which control the price policy of the company and its subsidiary companies; and the third part of the book is entitled "Twenty-one Reasons for Our Sales Policy."

Business Notes

THE HEIL CO., Milwaukee, Wis., announces its consolidation with the Hydro Hoist Co., a subsidiary. Clement C. Smith is chairman of the board of directors of the consolidated company. J. P. Heil, formerly vice-president and treasurer of the Heil Co., has been elected president and treasurer; Herman W. Falk, vice-president, and W. N. Chester, secretary. The board of directors consists of the officers and George P. Miller and William G. Thwaites. About a year ago the company completed a quarter of a million dollar building program, which now gives its factory a total floor space of 214,000 sq.ft.

C. O. BARTLETT & SNOW COMPANY, Cleveland, has recently opened a new office in the First National Bank Building, Chicago, under the management of S. G. Artingstall, Jr. Mr. Artingstall has been chief engineer for the J. C. Buckbee Company, Chicago, consulting engineers for cement plants, gravel washing and stone crushing plants and industrial buildings, and also vice-president and chief engineer of the United Engineering Company. Most recently he was district manager for the Stearns Conveyor Company.

J. S. ROBERTS, formerly connected with the United States Cast Iron Pipe & Foundry Co., died at his home in Cleveland, Ohio, on June 18. For the last 14 years he had served as resident manager of the Cleveland shop of the above company.

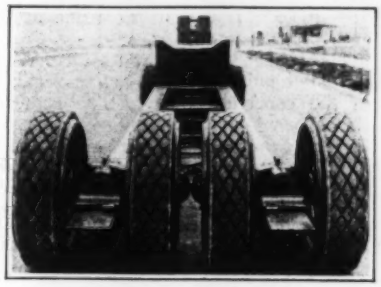
WILLIAM H. PETERS, vice-president, Jaeger Machine Co., Columbus, Ohio, died June 20, after an illness of five months. He had been identified with the Jaeger company for 21 years.

New Developments

Removable Trunnion Axles Aid in Loading 35-Ton Trailer

The type "H" trailer recently developed by the Fruehauf Trailer Company, Detroit, with two wheels in front and four wheels in the rear, has been designed particularly for the transporting of heavy construction equipment. It is built in capacities up to 40 tons and is designed to conform with road laws in those communities which limit the width of heavy-duty vehicles.

The main frame is constructed of reinforced H-beams. No platform is furnished with the trailer, since the wheels or crawler mountings of most construction machinery will straddle the beams, permitting the under-gear to rest on the H-beams of the trailer. The rear wheels of the trailer are mounted on trunnion axles that permit them to follow any road contour and at the same time evenly balance the loaded



trailer. A distinctive feature of the rear wheel assembly is the fact that the trunnion axles can be easily removed by jacking up the rear end of the trailer and loosening two bolts. With the rear wheels removed the frame is lowered and the load run up onto the frame. With the load in place, the rear end is jacked up and the trunnion axles are replaced.

Brakes can be installed on the front gear, operated by a railroad-type brake wheel in the center of the upper deck or can be provided on the four rear wheels, where they are operated by a separate lever for each pair of wheels. The length of the trailer from the drop to the front of the rear wheels is 22 ft. The over-all width of the frame is 4 ft. 9½ in., while the over-all width of the trailer is 8 ft. The loading height with wheels attached is 19 in.

Chemical Treatment of Wood Flooring Advantageous

A number of new products in the field of flooring materials have recently been developed by the E. L. Bruce Co., Memphis, Tenn. The basis of these new products lies in the development of what the company calls a "Cellizing" process. This consists in treating oak flooring with a chemical solution which is claimed to prevent any bad effects from atmospheric moisture and wood-boring insects. The flooring is also guaranteed against cupping, buckling and shrinkage. Because of its freedom from buckling, it is possible to use wide plank floors not possible with lumber in which shrinkage and expansion take place. The oak flooring treated by the company's process is made in widths as wide as 10 in., which are guaranteed to remain perfectly true and level.

Another new product is oak flooring block. These blocks are square units made of three or four pieces of regular oak flooring strips, fabricated by a steel spline through the back. Each block is a complete unit and is laid as such. The manufacturers claim for this method a great saving over the usual practice of laying individual pieces of a design floor independently. The block-type flooring is laid without the necessity of nails in a plastic cement which the company furnishes known as Everbond, and which is placed directly over sub-floors of wood or cement. It is claimed that the cement acts as a sound deadener and that no squeaking of the floor can at any time develop.

Manufacturers and Trade Associations

Calendar

Annual Meetings

TRACK SUPPLY ASSOCIATION, Chicago; annual exhibition and convention, Detroit, Sept. 18-20, 1928.

New Publications

Roller Bearings—ROLLWAY BEARING COMPANY, INC., Syracuse, N. Y., in its new catalog 4-A illustrates and describes its wide-series bearings, giving tables of sizes of the various types. The catalog also describes the company's so-called utility bearings which are designed to be used on unhardened shafts, these rollers being made of high carbon steel, unhardened. In addition to this catalog, several one-page bulletins have recently been announced, describing, respectively, self-aligning roller bearing pillow blocks, radial bearings, pillow blocks with standard bearings and roller bearings in international standard sizes.

Crawler Tracks—W. A. RIDDELL COMPANY, successor to HADFIELD-PENFIELD STEEL COMPANY, Paris, Ohio, has published a bulletin describing its "Cahl" crawler track for use on Fordson tractors.

Concrete Pipe—ASPHALTO CONCRETE CORPORATION, 1440 Broadway, New York, N. Y., in its bulletin No. 3, describes the Moir-Buchanan process for making concrete pipe, a combination of centrifugal and mechanical action; the Billé-Ligonnet process for applying asphalt lining to concrete pipes and flat surfaces, and a special process for making concrete poles and conduits. The booklet illustrates and describes the various operations in these processes, the rights for the use of which are all controlled by the Asphalto Concrete Corporation.

Tractors—CLEVELAND TRACTOR COMPANY, Cleveland, Ohio, has published a new catalog illustrating and describing its four models of crawler tractors, the "20," the "30," the "40" and the "100." The use of the tractor in road service is particularly stressed. Complete specifications are given for each model, the company's patented steering mechanism is illustrated and described, and two pages are devoted to a description of the "one-shot" oiling system used on all of the models.

Business Side of Construction

Facts and Events That Affect Cost and Volume

Six Months' Awards Exceed Last Year's By 17 Per Cent

REPEATEDLY records for contract lettings have been surpassed. The average week of June, 1928, showed $80,840,000, while December, 1927, March and April, 1928, were former record months with only about $75,000,000 average weekly value of contracts. Compared with last month and a year ago the increases were 13 and 15 per cent, respectively.

Contracts awarded this year to date are valued at $1,773,936,000, and for the first six months of last year $1,514,979,000, or an increase of 17 per cent. Several classes showed significant increases—streets and roads, 37 per cent; industrial buildings, 25 per cent, and commercial buildings, 24 per cent. Federal government and bridges were classes which increased less than 10 per cent; and decreases were registered for water-works, sewers, excavations and unclassified work. The actual value of private engineering construction contracts let during six months of 1928 were $1,108,500,000, and public $665,500,000, compared with $910,800,000 and $604,100,000 last year, or gains of 22 and 10 per cent, respectively.

The Middle Atlantic and Middle West were not only the most active sections in the construction industry but they also showed large percentage increases for six months of 1928 over last year, 39 and 18 per cent respectively. Marked activity in the South is indicated by a 23 per cent increase. New England showed only a 1 per cent gain and West of the Mississippi and Far West awards were 1 and 7 per cent lower than last year.

June, 1928, included contract awards for only four weeks and both May, 1928, and June, 1927, covered reports for five weeks. On the basis of weekly activity the following tabulation shows average weekly lettings for last month with the percentage change from the preceding month and the corresponding month last year.

	Weekly Contracts June, 1928 (Millions of Dollars)	Per Cent Change From May, 1928	Per Cent Change From June, 1927	Weekly Contracts May, 1928 (Millions of Dollars)	Weekly Contracts June, 1927 (Millions of Dollars)
Water-works	1.07	—61	—26	2.72	1.44
Sewers	3.14	+53	+44	2.07	2.17
Bridges	2.59	—37	+16	4.13	2.22
Excavations	1.99	+360	—20	.43	2.49
Streets and roads	16.81	+1	+7	16.68	15.66
Industrial buildings	5.40	—3	+40	5.55	3.85
Commercial buildings	44.30	+28	+35	34.73	32.92
Federal government	1.36	+68	+126	.81	.60
Unclassified	4.18	—2	—54	4.29	9.13
Total private	47.71	+22	+31	39.32	36.52
Total public	33.13	+3	—2	32.09	33.96
All classes	80.84	+13	+15	71.41	70.48

Four sections of the country had weekly contracts of greater value than either the preceding month or June, 1927. These were the South, Middle West, West of Mississippi and Far West. The Middle West showed conspicuously in this comparison, due to a $45,000,000 contract for a manufacturers' mart, hotel and garage in Chicago having been awarded during the last week of the month. This was the outstanding large job of the year.

Building Materials Prices Backed by Heavy Demand

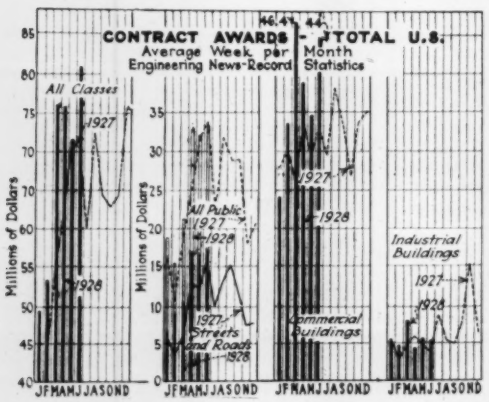
Building materials prices continue the steady upward movement noted since January, 1928. With a volume of contract lettings on engineering construction projects for the first half of this year considerably above that of the corresponding period in either 1927 or 1926, probabilities are slight for a marked decline in three-quarter prices.

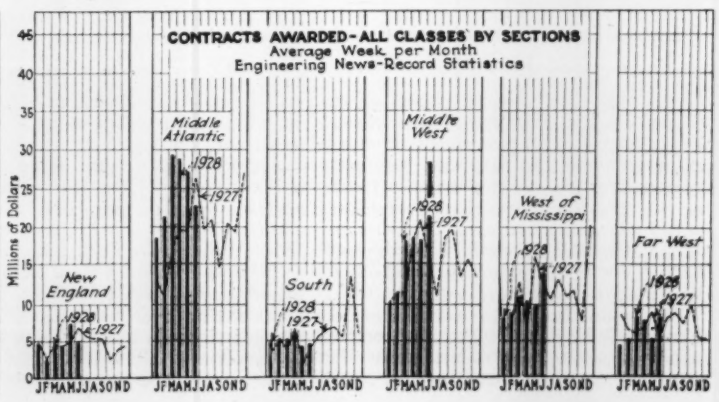
Lumber prices show a greater number of advances in the last month than some of the other major groups. This firmness is evident in all sections of the

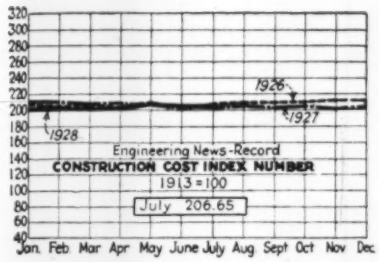
VALUE OF CONTRACTS BY SECTIONS IN THE UNITED STATES AND TOTAL FOR CANADA, JUNE, 1928

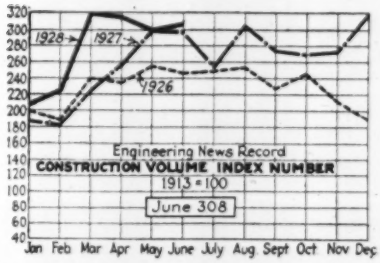
Thousands of dollars (-000 omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States	Jan. 1 to Date, U. S.	Canada
Waterworks	$45	$1,061	$380	$1,430	$1,104	$264	$4,284	**$28,803**	25
Sewers	292	2,069	500	7,490	1,210	1,008	12,569	**51,406**	439
Bridges	1,192	2,136	1,431	2,603	2,141	850	10,353	**68,913**	173
Excavations, drainage, etc.	10	268	15	212	6,602	849	7,956	**15,309**	95
Streets and roads	3,485	16,578	8,783	14,296	15,814	8,288	67,244	**332,523**	2,795
Industrial buildings	2,066	4,690	1,461	4,824	5,800	2,760	21,601	**146,294**	3,050
Commercial buildings	11,759	53,300	4,808	76,408	15,792	15,133	177,200	**968,726**	5,029
Federal government	150	2,685	157	537	1,249	652	5,430	**24,801**	.....
Unclassified	317	8,342	30	1,371	4,376	2,281	16,717	**137,161**	985
June, 1928	19,316	91,129	17,565	109,171	54,088	32,085	323,354	.....	12,496
May, 1928	36,903	134,896	20,445	89,537	48,916	26,362	357,059	.....	13,329
June, 1927	33,534	130,474	19,731	81,119	60,817	26,753	352,428	.....	19,747
Year to date, 1928	**121,787**	**643,636**	**127,294**	**448,062**	**265,257**	**167,900**	.....	**1,773,936**	**76,547**
Year to date, 1927	120,072	463,118	103,471	379,029	268,737	180,552	1,514,979	.....	57,339









ENGINEERING NEWS-RECORD CONSTRUCTION COST AND VOLUME INDEX NUMBERS

country, especially in the cases of fir and pine. Yellow pine in the New Orleans market is at a record price for the last two years. Curtailed production in June boosted both fir and pine at Minneapolis $2 per 1,000 ft. on all sizes. West Coast mills are preparing for the regular July 4 shutdown, to last several weeks. Douglas fir prices are already higher than they were a month ago at Seattle, the chief market.

Cement prices showed thair usual stability. No important changes took place in the month. Reserve mill stocks of the entire nation are fully 10 per cent heavier than they were a year ago. Volume of shipments from mills to dealers and consumers, however, is sufficiently above production to insure the sharp drop in summer reserve stocks.

Brick prices, while showing few changes compared with June levels, have not recovered from the decline that occurred during the spring months. The Common Brick Manufacturers' Association reports a smaller number of burned brick on hand and a greater number of orders on books.

Steel shapes and plates at Pittsburgh sell at $1.85 per 100 lb., f.o.b., in large mill lots. Reinforcing bars, $\frac{3}{4}$ in. and larger, are $1.95 per 100 lb. These prices prevailed a month ago and are approximately 5c. per 100 lb. above those of July, 1927. In the first five months of this year 21,049,919 tons of ingots was produced, an increase of 3.4 per cent over the 1927 output in this period. Production in June was at 75 per cent capacity, against 87½ for May and an average of 89 in March and April, the high months.

The most important June price advances are for the following materials: Brick, $1 at Seattle and $1.75 in Atlanta; lime, 15c. per ton, Boston and Kansas City; re-rolled rails, $2 per ton, Pittsburgh; cement, 10c. per barrel in Atlanta; cast-iron pipe, $1 per ton at principal mills and f.o.b. points.

Declines were as follows: Asphalt, $1 per ton in Atlanta; linseed oil, 1c. per pound, New York; galvanized sheets, 5c., blue annealed, 10c., and black, 25c. per 100 lb., all at Pittsburgh; hollow tile, 1c. per block, Atlanta; reinforcing bars, 5c. per 100 lb., Birmingham; curbing, 5c. per linear foot, St. Louis; heavy melting scrap, 25c. per ton, Chicago.

Record Volume Index for June; Cost Change Negligible

The *Engineering News-Record* Construction Cost Index Number for July is 206.65 as compared with 206.15 in June and 203.68 in July, 1927. The slight advance of 0.5 point in the July number over that of the month preceding was due to a slight rise in the average common labor rate.

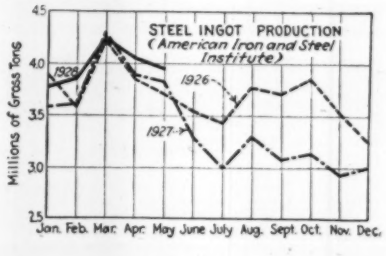
The *E. N.-R.* Construction Volume Index Number, 308, for June, 1928, is 9 points above that of May and represents the highest June volume on record. The latest figures, with comparisons, are given below:

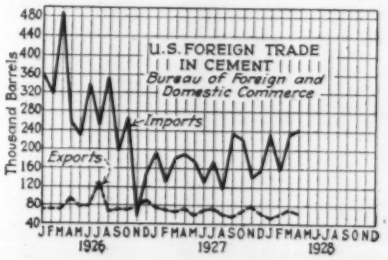
E. N.-R. Cost Index		E. N.-R. Volume Index	
July, 1928	**206.65**	**June, 1928**	**308**
June, 1928	206.15	May, 1928	299
July, 1927	203.68	June, 1927	297
Peak June, 1920	273.80	1927 (average)	263
1927 (average)	206.24	1926 (average)	228
1913 (average)	100.00		
1927		1927	
January	211.50	January	187
February	210.15	February	182
March	208.80	March	226
April	209.00	April	257
May	206.80	May	299
June	205.55	June	297
July	203.68	July	252
August	205.50	August	306
September	203.60	September	273
October	204.40	October	269
November	201.98	November	272
December	203.90	December	319
1928		1928	
January	203.90	January	208
February	204.65	February	225
March	204.65	March	318
April	206.40	April	316
May	207.00	May	299

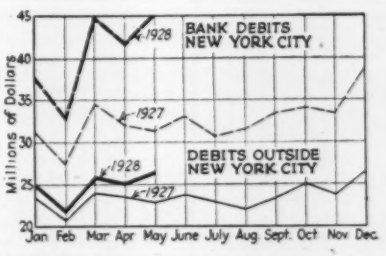
Business Good, With Money Rates at Highest in Seven Years

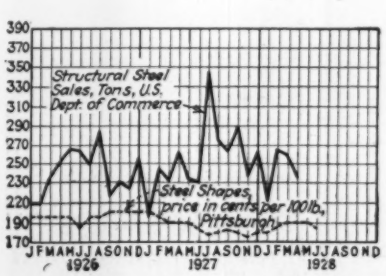
All authorities are agreed that the first half of 1928 has been a model, which it is believed the second half will be able to equal—not alone in volume of trade but in stability as well. At the same time it is reassuring to note a steady continuation of the modern practice of fitting production to consuming needs. It is also indicative of soundness that this attitude of caution should persist despite a record volume of construction and steel output, increased net operating income of the railroads, and the revival of the automobile industry, to mention only four outstanding good signs of the times.

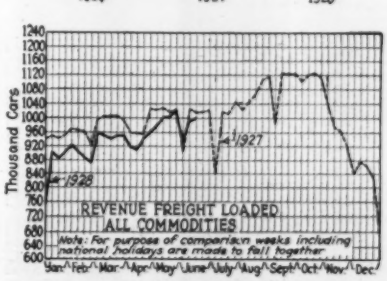
In the money market, three high records for the last seven years were established for interest rates on call funds, time money and call loans on bankers' bills, Federal Reserve funds and call loan renewal rate. The call loan re-

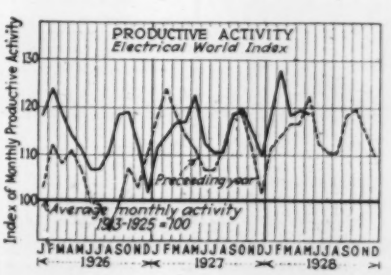



U.S. FOREIGN TRADE IN CEMENT
Bureau of Foreign and Domestic Commerce
Thousand Barrels
Imports
Exports
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928


BANK DEBITS NEW YORK CITY
DEBITS OUTSIDE NEW YORK CITY
Millions of Dollars
1928
1927
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec


Structural Steel Sales, Tons, U.S. Dept. of Commerce
Steel Shapes, price in cents per 100 lb. Pittsburgh
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928


Thousand Cars
1927
1928
REVENUE FREIGHT LOADED
ALL COMMODITIES
Note: For purpose of comparison weeks including national holidays are made to fall together.
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.


PRODUCTIVE ACTIVITY
Electrical World Index
Index of Monthly Productive Activity
Preceding year
Average monthly activity 1923-1925=100
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928

STEEL PRODUCTION—ELECTRICAL ENERGY CONSUMED—FREIGHT LOADINGS

newal rate went to 10 per cent on July 2, which is the peak since Nov. 10, 1920. The rate of 6 per cent on 30- and 60-day time loans is another new high for seven years, while federal funds or the surplus balance of member banks at the reserve bank jumped to 5¼ bid, 5½ asked. Call loans on bankers' acceptances rose 1½ per cent to a figure of 6½ bid on June 27, the record since 1918.

One of the reasons for these higher rates is the imminent call which the comptroller of the currency is expected to make upon the banks. To add to the stringency caused by the so-called window-dressing efforts of banking institutions at this time are the coming quarterly and semi-annual and fiscal year settlements and dividend disbursements, which will withdraw $1,000,000,000 from the banks by check. This sum will find its way back to the money market and $50,000,000 of holiday currency will return to the Federal Reserve Bank.

Continued tightening of credit, however, even though its single purpose is to reduce the fever of speculation, sometimes has the unfortunate effect of lowering the legitimate vitality of construction investment. It is unlikely that the latter will happen at present. The country is in a mood to build. Rising interest rates have not prevented a record volume of new financing—$4,181,000,000 in the first half of 1928, compared with $4,170,000,000 in the corresponding period of 1927 and $3,164,000,000 in the first half of 1926. Bond sales on the New York Stock Exchange totaled $1,690,000,000, compared with $1,842,000,000 in the first six months of 1927.

Certain authorities predict a period of commodity inflation. In possible substantiation of this, the *Annalist* Weekly Index of Wholesale Commodity Prices for June 26 is 150.1, against 148.9 the week before. This rise follows six weeks of continuously declining wholesale prices. The figure for June, 1927, was 149.4.

Survey Shows Building Wages Firm at Highest Levels

Wages of building trades workers throughout the country are holding firm at the highest levels in history, and there is little likelihood of any material reduction in rates in 1928, according to a national survey of building labor conditions just completed by the Aberthaw Company, Boston.

"Spring wage adjustments have had very little effect on the general wage level of the country," says the survey. "The majority of building crafts appear to be willing to go along under present conditions and peacefully adjust pending disputes.

"Indications are that the organized building trades will not press for further wage increases this summer, except in a few localities, but will now attempt to consolidate their forces into a campaign for the five-day week. Already, in a number of cities, this is the primary issue.

Conditions as to employment in the building trades continue spotty. Birmingham, for instance reports increasing unemployment in all trades. In New York City the demand for common laborers is particularly light. Some of the smaller contractors in New York are going so far as to employ only those who can furnish their own picks and shovels. On the other hand, fewer workers are idle than a month ago in San Francisco and Kansas City, while Detroit dealers report an unusually large volume of current demand for building materials.

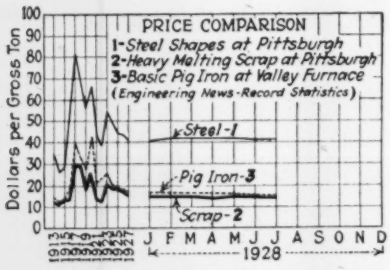
The average skilled labor rate for the entire country is $1.34⅔ per hour, the same as in June. The current rate is 1⅜c. per hour above the July, 1927, average, of $1.33. Common laborers receive an average rate of 55¼c. per hour, compared with 55½c. in June and 55½c. in July, 1927.

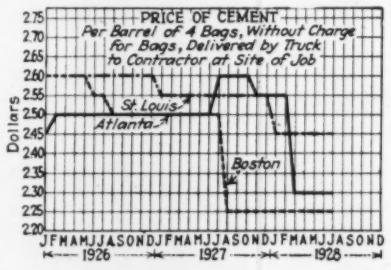
Following are the wage changes noted in the last month:

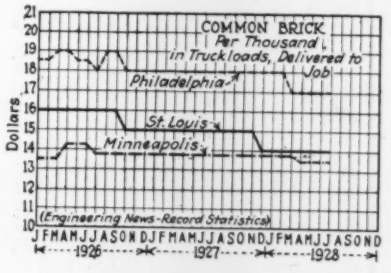
	July, Per Hour	June, Per Hour
Hoisting Engineers:		
Kansas City, Mo.	$1.25@$1.37½	$1.25
Structural Ironworkers:		
Boston	1.37½	1.25
Kansas City, Mo.	1.25@ 1.37½	1.25
Common Laborers:		
Birmingham	0.30@ 0.35	0.25@0.35
St. Louis	0.45@ 0.75	0.40@0.75

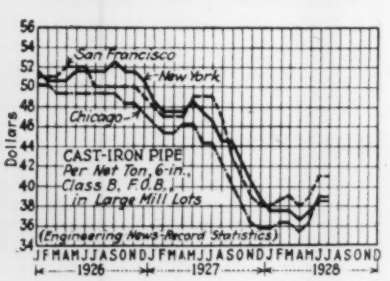
CURRENT BUILDING TRADES WAGE RATES PER HOUR

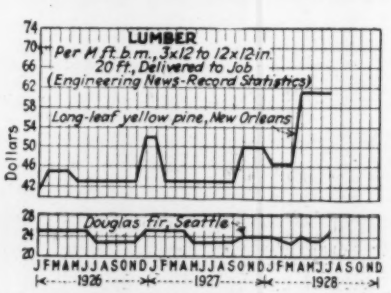
Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1.25@1.40	$0.60@0.70	$0.60@1.00	$0.50	.....	$0.75@1.25	$0.25@.35
Baltimore	1.62½	1.00@1.10	1.00@1.37½	1.00	$0.65	1.00@1.25	.35
Birmingham	1.50	1.00	1.25	.50	.....	1.75	.30@.35
Boston	1.40	1.25	1.25	.79	1.15	1.37½	.45@.74
Cincinnati	1.50	1.37½	1.37½	.97½	1.37½	1.37½	.45@.60
Chicago	1.62½	1.50	1.00@.150	.90@.96½	1.50	1.50	.90
Cleveland	1.62½	1.37½	1.37½	.87½	1.10	1.50	.87½
Dallas	1.67½	1.12½	1.25	.40@.75	1.25	1.25	.35@.50
Denver	1.50@1.62½	1.25	1.25@1.37½	.87½@1.00	.....	1.25	.50@.62½
Detroit	1.56¼	1.00@1.25	1.00@1.10	.90	1.00@1.10	1.00@1.25	.50@.60
Kansas City	1.50	1.25	1.25@1.37½	.90	1.25	1.25@1.37½	.35@.75
Los Angeles	1.25	1.00	1.00	1.12½	.87½	1.00	.50
Minneapolis	1.25@1.37½	.87½@.95	.87½	.75	.....	1.00	.45@.60
Montreal	1.12	.75	.75	.40	.50	.80@1.00	.30@.35
New Orleans	1.50	.90	1.25	.75	.80@1.00	1.25	.30@.40
New York	1.75	1.50	1.75	1.12½	1.00@1.12½	1.75	.90½
Philadelphia	1.62½	1.12½@1.25	1.02½	.70@1.12½	1.00	1.37½@1.50	.45@.75
Pittsburgh	1.70	1.50	1.43¾@1.56¼	1.12½	.....	1.50	.50@.80
St. Louis	1.75	1.50	1.50@1.65	1.15@1.25	1.25	1.50	.45@.75
San Francisco	1.37½	1.12½	1.00@1.12½	.87½	1.12½	1.37½	.50@.60
Seattle	1.37½	1.12½	1.00@1.12½	1.00	1.00@1.12½	1.12½@1.25	.62½@.70

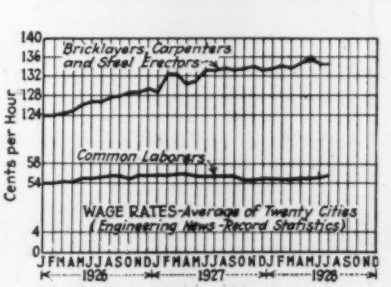



PRICE OF CEMENT
Per Barrel of 4 Bags, Without Charge for Bags, Delivered by Truck to Contractor at Site of Job
St. Louis
Atlanta
Boston
Dollars
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928


COMMON BRICK
Per Thousand in Truckloads, Delivered to Job
Philadelphia
St. Louis
Minneapolis
(Engineering News-Record Statistics)
Dollars
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928


San Francisco
New York
Chicago
CAST-IRON PIPE
Per Net Ton, 6-in., Class B, F.O.B. in Large Mill Lots
(Engineering News-Record Statistics)
Dollars
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928


LUMBER
Per M ft b.m., 3x12 to 12x12 in. 20 ft, Delivered to Job
(Engineering News-Record Statistics)
Long-leaf yellow pine, New Orleans
Douglas fir, Seattle
Dollars
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928


Bricklayers, Carpenters and Steel Erectors
Common Laborers
WAGE RATES-Average of Twenty Cities
(Engineering News-Record Statistics)
Cents per Hour
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1926 1927 1928

PRICES OF CONSTRUCTION MATERIALS AND WAGES OF LABOR

E. N.-R. Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per gross ton, f.o.b.:

CINCINNATI	
No. 2 Southern (silicon 2.25@2.75)	$19.69
Northern Basic	20.89
No. 2 Southern Ohio (silicon 1.75@2.25)	21.19
NEW YORK, tidewater delivery	
Southern No. 2 (silicon 2.25@2.75)	25.62
BIRMINGHAM	
No. 2 Foundry (silicon 2.25@2.75)	*15.50*
PHILADELPHIA	
Eastern Pa., No. 2X (silicon 2.25@2.75)	21.76
Virginia No. 2 (silicon 2.25@2.75)	27.17
Basic	21.26
CHICAGO	
No. 2 Foundry Local (silicon 1.75@2.25)	20.00
No. 2 Foundry Southern (silicon 2.25@2.75)	22.01
PITTSBURGH, including freight charge ($1.76) from the Valley	
No. 2 Foundry Valley (silicon 1.75@2.25)	20.26
Basic	19.26
Bessemer	21.26

SCRAP—The prices following are f.o.b. per ton paid by dealers:

	New York Per Gross Ton	Chicago Per Gross Ton	Birmingham Per Gross Ton
No. 1 railroad wrought	*$9.50*@$10.00	*$12.50*@$13.00	$11.00@$11.50
Stove plate	**8.50@ 9.00**	13.00@ 13.50	9.00@ 9.50
No. 1 machinery cast	12.50@ 14.00	15.00@ 15.50	12.50@ 14.00
Machine shop turnings	*6.00@ 6.50*	*6.75@ 7.25*	7.00@ 7.25
Cast borings	*6.00@ 6.50*	9.00@ *9.50*	7.25@ 7.50
Railroad malleable	10.00	*12.50@ 13.00*	10.25@ 10.75
Re-rolling rails	10.00@ 10.50	*14.25@ 14.75*	10.25@ 10.75
Re-laying rails	23.00@ 24.00	.....	23.00@ 24.00
Heavy melting steel, No. 1	9.50@ 9.85	*12.50@ 13.00*	.....
Iron and steel pipe	8.25	.....	.....

Railway Supplies

STEEL RAILS—Per gross ton f.o.b. for large mill lots:

	Pittsburgh	Birmingham	Chicago
Standard bessemer rails	$43.00	$43.00	$43.00
Standard openhearth rails	43.00	43.00	43.00
Light rails, 25 to 45 lb.	36.00	34@36	36@38
Re-rolled rails	30@32	34@36	.....

RAILWAY TIES—For fair-sized orders, f. o. b., the following prices per tie held:

		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
New York	Long-leaf sap pine, untreated	$1.10	$1.30
	Creosoted—prices on application.		
Birmingham	Southern pine untreated	1.10	1.25
	Southern pine, creosoted	1.60	1.75
St. Louis	White oak, untreated	1.20	1.80
	Red oak, creosoted	1.50	2.30
	Sap pine or cypress, untreated	1.00	1.60
Chicago	White oak, heart, untreated	1.40	1.78
	Oak, empty cell, creosoted	1.80	2.40
	Oak, zinc treated	1.60	2.10
	Southernpine, creosoted	1.60	2.10
San Francisco	Douglas fir, green, untreated	.82	1.14
	Douglas fir, empty cell, creosoted	1.73	2.32

TRACK SUPPLIES—Per 100 lb. f.o.b. Pittsburgh mill for large mill lots together with warehouse prices at other places named:

	Pittsburgh	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅝-in. and larger	$2.80	$3.55	$3.65	$3.85	$3.00
Track bolts	3.80	4.55	4.65@4.77	5.35	3.90
Standard section angle bars, splice bars or fish plates	2.75	3.40	*3.62*	4.25	3.00
Tie plates	2.15	2.15*	2.58	.....	.....

*At Chicago mills in carloads.

Pipe

WROUGHT STEEL AND IRON PIPE—The following discounts from list are for large mill lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 to 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

WROUGHT-STEEL PIPE—On deliveries from warehouses at the places named the following discounts from list hold for standard steel pipe:

	Black		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	50%	54%	49%
2½ to 6 in. lap welded	45%	>1%	46%
	Galvanized		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	36%	41%	36%
2½ to 6 in. lap welded	32%	38%	33%

WROUGHT STEEL PIPE LIST

Size, Inches	List Price per Foot	Diameter in Inches—External	Diameter in Inches—Internal	Thickness Inches
⅛	$0.17	1.315	1.049	.133
¼	.23	1.66	1.38	.14
⅜	.27½	1.9	1.61	.145
½	.37	2.375	2.067	.154
⅝	.58½	2.875	2.469	.203
¾	.76½	3.5	3.068	.216
⅞	.92	4.0	3.548	.226
1	1.09	4.5	4.026	.237
1¼	1.27	5.0	4.506	.247
1½	1.48	5.563	5.047	.258
2	1.92	6.625	6.065	.28
2½	2.38	7.625	7.023	.301
3	2.50	8.625	8.071	.277
3½	2.88	8.625	7.981	.322
4	3.45	9.625	8.941	.342
5	3.20	10.750	10.192	.279
5	3.50	10.750	10.136	.307
5	4.12	10.750	10.020	.365
6	4.63	11.750	11.000	.375
8	4.50	12.750	12.090	.330
8	5.07	12.750	12.000	.375

CAST-IRON PIPE—Prices per net ton for bell and spigot pipe, Class B and heavier, f. o b., in large mill lots:

	Birmingham	Burlington, N. J.	New York
4 in.	$36.00	**$40.00**	**$42.60**
6 in. and over	33.00	**37.00**	**39.60**

	Pittsburgh	Chicago	St. Louis	San Francisco
4 in.	**$44.50**	$44.20@**$45.20**	**$41.60**	**$46.00**
6 in. and over	**41.50**	41.20@**42.20**	**38.60**	**43.00**

Gas pipe and Class "A," $3.00 per ton extra.

CLAY DRAIN TILE—Prices are delivered per 1,000 lin.ft.:

Size, In.	New York	St. Louis	Birmingham	San Francisco	Dallas
3	$45.00	$50.00	$45.00	.....	.....
4	56.00	50.00	56.00	$67.50	$73.00
5	.....	85.00	80.00	86.25	110.00
6	90.00	85.00	105.00	112.50	118.00
8	150.00	195.00	175.00	187.50	150.00

SEWER PIPE—Prices are delivered in cents per foot for standard pipe; 6, 8 and 12-in. single strength and 18, 24, 30 and 36-in. double strength:

	6-In.	8-In.	12-In.	18-In.	24-In.	30-In.	36-In.
Atlanta	$0.20	$0.26½	$0.44½	.....	$1.70	.....	.....
Baltimore	.....	.24	.46	.....	1.53	.....	$6.50
Birmingham	.135	.2215	.4015	$1.4625	2.665	$3.90	5.06
Boston	.15	.27	.51	.....	1.85	.....	5.50
Cincinnati	.....	.21	.405	.....	1.35	.....	4.8175
Chicago	.16	.28	.54	1.25	2.25	.....	.....
Dallas	*.256*	*.42*	*.794*	1.70	3.00	.....	.....
Denver (f.o.b.)	.185	.27	.47	1.35	1.70	.....	.....
Detroit (f.o.b.)	.18	.28	.6075	1.50	2.70	.....	.....
Kansas City (f.o.b.)	.21	.29	.52	.....	1.90	.....	3.80
Los Angeles	.21	.27	.486	.....	1.74	.....	.....
Montreal	.....	.45	.75	.....	2.60	.....	.....
Minneapolis (f.o.b.)	.1575	.25	.45	1.05	1.80	3.75	4.94
New Orleans	.195	.325	.5525	1.105	2.112	.....	.....
New York	*.20*	*.32*	.61	1.50	2.70	5.12	7.91
Philadelphia (f.o.b.)	.....	.182	.351	.....	1.215	.....	4.6125
Pittsburgh (f.o.b.)	*.0945*	*.147*	*.2835*	.90	1.62	3.024	4.8175
St. Louis	.1645	.26	.468	1.092	1.872	3.65	4.80
San Francisco	.21	.30	.54	1.32	2.16	3.60	.....
Seattle	.14	.22	.54	1.26	2.16	3.60	.....

Road and Paving Materials

ROAD OILS—Price per gal. in tank cars, 8,000 gal. minimum, f.o.b., at places named:

New York, 40@50% asphalt	(at terminal)	$0.0725 @$0.075
New York, 50@60% asphalt	(at terminal)	.0675 @ .072
St. Louis, 40@50% asphalt		.0418
St. Louis, 50@60% asphalt		*.0407*
Birmingham, 40@50% asphalt		.0525
Birmingham, 50@60% asphalt		.0475
Dallas, 40@50% asphalt		.061
Dallas, 50@60% asphalt		.06

E. N.-R. Prices of Construction Materials

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (Texas)	$24.50	.....
Boston (Mexican)	24.00	$19.00
Chicago (Texas)	24.50	21.30
San Francisco, (f.o.b. refinery, Oleum, Calif.)	18.00	12.00
Dallas (Texas)	26.00	.....
Seattle, ("D" grade, California, f.o.b Richmond refinery)	19.50	13.50
Denver (California)	35.00	.....
Minneapolis, (Stanolind, f.o.b. Twin Cities)	28.10	22.10
St. Louis (Mexican)	23.50	19.50
Baltimore (Standard Oil, f.o.b. refinery)	21.75	17.75
Montreal (Imperial)	28.00	21.50
Atlanta (Mexican)	*22.50*	*18.50*
Detroit (Mexican)	24.00	19.00
Cincinnati (Kentucky Rock)	.....	11.65
Maurer, N. J. (Bermudez)	30.00	.....
Maurer, N. J. (Trinidad)	23.00	.....
Philadelphia (Mexican)	20.00	18.00
Kansas City, Mo. (Texas)	27.30	25.30
Los Angeles ("D" Grade, California, f.o.b. El Segundo)	18.00	12.00
Birmingham (Mexican)	27.00	21.00
New Orleans (Mexican)	20.00	17.00

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton. Drums used in New York.

PAVING STONE—Prices, f.o.b., in carloads or cargo lots for 5-in. blocks:

New York (grade I)	granite, 5-in., 30 blocks per sq.yd.	$150.00 per M.
San Francisco	Basalt block 4x7x8	70.00 per M.
Chicago	about 5x8x5 dressed	3.60 per sq.yd.
	about 5x8x5 common	3.25 per sq.yd.
Boston	Granite	135.00 per M.
Atlanta	Granite	2.50 per sq.yd.
Detroit	Granite	3.00 per sq.yd.
Baltimore	Granite	3.00 per sq.yd.
Montreal	Granite	104.75 per M.
New Orleans	Granite, 4x8x4	2.75 per sq.yd.
Cincinnati	Granite	110.00 per M.
St. Louis	Granite	3.30@3.40 per sq.yd
Kansas City	Granite	3.50 per sq.yd.
Philadelphia	Granite	3.90@4.25 per sq.yd.
Minneapolis	Sandstone	2.74 per sq.yd.

FLAGGING—Prices in fair-sized quantities, alongside dock:

New York	Bronx, 4 ft. wide	$0.24 per sq.ft.
	Manhattan, 4 ft. wide	.24 per sq.ft.
	Queens, 5 ft. wide	.26 per sq.ft.
	6x24-in. cross-walk	1.30 per lin.ft.

CURBING—*New York*: Bluestone, f.o.b. barge, New York, 5x16 in., rough, 90c. per lin.ft., cutting charges extra.
St Louis: Class "B" straight, delivered, 5x16 in., 80c. per lin.ft.; roundings, $1.15 per lin.ft.
Birmingham: Limestone, 5x18-in., f.o.b., $1.05 per lin.ft.

WOOD-BLOCK PAVING—Prices f.o.b. in carloads:

	Size of Block	Treatment	Per Sq.Yd.
New York	3	16	$2.40
New York	3½	16	2.79
Boston	3½	18	2.40
Chicago	4	16	2.25
Chicago	3½	16	2.10
St. Louis	3½	16	2.20
St. Louis	4	16	2.50
Minneapolis	3½	16	2.50
Atlanta	3½	16	2.00
New Orleans	3	16	2.20
New Orleans	3½	16	2.30
New Orleans	4	16	2.40
Dallas	4	18	3.90
Montreal	4	16	4.50
Detroit	3	16	1.94
Cincinnati	3½	16	2.35
Kansas City	4	16	2.50

Construction Materials

SAND AND GRAVEL—Prices are per cu.yd. delivered. Weight of sand, 1½ tons per cu.yd.; gravel, 1½ tons per cu.yd. unless otherwise specified in pounds.

	Gravel		Sand
	1½ In.	¾ In.	
New York	$3.25@$3.50	$3.25@$3.50	$2.00@$2.25
Denver (2,700)	1.50	1.50	1.50
Chicago	2.10@2.25	2.10@2.25	2.10@2.25
St. Louis, per ton	2.30	2.30	1.90@2.30
Seattle (3,200) (2,850)	1.00	1.00	1.00
Dallas	2.50	2.50	2.25@3.00
Minneapolis (2,800)	2.25 ton	2.25 ton	1.00
Cincinnati, per ton	1.90	1.60	1.60
San Francisco (bunkers) (2,800)	1.80	1.80	1.40
Boston, per ton	1.90	1.90	1.35
New Orleans (2,700) (2,500)	2.40	2.40	1.50
Los Angeles, per ton, f.o.b.	1.80	1.80	1.30
Atlanta, per ton	3.00	3.00	2.25
Detroit (2,600)	3.00	3.00	2.50
Baltimore, per ton	2.40	2.60	1.70
Montreal, per ton	1.90	1.50	1.20
Birmingham (2,600)	3.00	3.00	2.65
Philadelphia, per ton	2.05@2.90	2.05@2.90	1.40@2.25
Kansas City, Mo.	2.40	2.40	.70 ton at pit
Pittsburgh, per ton, f.o.b.	.85	1.05	1.25

Note: New York gravel weighs 2,800@3,000 lb. and sand, 2,700 lb.

CRUSHED STONE—Prices are per cu.yd. delivered. Weight 1½ tons per cu. yd., unless otherwise specified in pounds:

	1½ In.	¾ In
New York, Limestone,	$3.25@3.50	$3.25@3.50
Chicago, Limestone	2.10@2.25	2.10@2.25
St. Louis, per ton, f.o.b	1.73	1.73
Dallas	3.25	3.40
San Francisco, Trap rock, bunkers (2,400)	1.70	1.70
Boston, per ton	2.25	2.25
Minneapolis, Limestone, per ton	2.25	2.25
Kansas City, Limestone, per ton, (2,450)	2.00	2.00
Denver, Granite (2,700)	2.50	2.50
Seattle, (2,700)	1.90	1.90
Atlanta, per ton	3.00	3.00
Cincinnati, per ton	2.25	2.25
Los Angeles, per ton, f.o.b.	1.80	1.80
Detroit, Limestone, per ton	2.50	2.60
Baltimore	2.75	2.85
Montreal, per ton		2.10
Philadelphia, Limestone, per ton	2.30@3.15	2.30@3.15
Pittsburgh	2.75	2.75
Cleveland, per ton	3.00	3.00
Birmingham, Limestone,	2.50	2.50

CRUSHED SLAG—Price of crushed slag in carloads, per net ton, at plant:

	1¼-In.	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.40	$2.00	$1.30
Buffalo District	1.25	1.35	2.25	1.25
Birmingham, Ala.	.90	1.25	2.05	.80
Cleveland, Ohio	1.20	1.20	.....	1.30
Eastern Pa. and Northern N. J.	1.25	1.25	2.00	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	....	1.25

LIME—Prices delivered to job:

	Hydrated, per Ton		Lump, per Barrel	
	Finishing	Common	Finishing	Common
New York	$21.00@22.00	$14.00@15.00	$4.00@4.10*	$3.15@3.25*
Chicago	20.00	18.00	.....	1.50†
St. Louis	24.00	18.00	2.50†	15.00‡
Boston	**20.00**	**14.00**	3.85*	3.00*
Dallas	20.00	.....	.....	18.00‡
Cincinnati	16.80	13.20	.....	13.20‡
San Francisco	27.50	*24.00*	.....	1.70†
Minneapolis	25.50	21.00	.....	1.70†
Denver	32.00	24.00	.....	2.75@3.00*
Detroit	19.20	14.80	2.20†	2.20†
Seattle, paper sacks	24.00	.....	.....	2.80*
Los Angeles	26.00	18.00	2.40†	19.00‡
Baltimore	20.00	14.00	2.55†	.....
Montreal	21.00	21.00	.....	15.00‡
Atlanta	17.50	15.00	2.30†	2.10†
New Orleans	.....	.....	.....	2.00†
Philadelphia	22.00	15.00	.....	.....
Kansas City	**20.00**	**17.50**	2.50†	**2.25†**
Birmingham	22.00	16.00	2.40†	1.85†
Pittsburgh	22.00	18.00	.....	.....

*Per 280-lb. bbl. (net). †Per 180-lb. (net). ‡Per ton.

NATURAL CEMENT—Prices per bbl. delivered to contractors, without charge for bags:

Kansas City, Ft. Scott	$1.50
Cincinnati, Utica	1.72
St. Louis, Carney	2.25
Birmingham, Magnolia pozzolan cement	2.60

PORTLAND CEMENT—Prices per bbl. delivered to contractors, in carloads, *without charge for bags*. Cash discount not deducted.

	July 5, 1928	One Month Ago	One Year Ago
New York	$2.25@$2.35	$2.25@$2.35	$2.35@$2.50
Jersey City	2.35	2.35	2.13f.o.b.
Boston	2.35	2.25	2.00
Chicago (f. o. b.)	2.05	2.05	2.05
Pittsburgh (f. o. b.)	2.04	2.04	2.04
Cleveland (f. o. b.)	2.24	2.24	2.24
Detroit (f. o. b.)	1.90	1.90	2.15
Indianapolis, (f. o. b.)	2.19	2.19	2.19
Milwaukee (f. o. b.)	2.20	2.20	2.20
Duluth (f. o. b.)	2.04	2.04	2.04
Peoria (f. o. b.)	2.22	2.22	2.22
Cedar Rapids (f. o. b.)	2.24	2.24	2.24
Davenport (f. o. b.)	2.24	2.24	2.24
St. Louis	2.45	2.45	2.05f.o.b.
San Francisco	2.41	2.41	2.51
New Orleans	2.40	2.40	2.40
Minneapolis (f. o. b.)	2.22	2.22	2.22
Denver	2.85	2.85	2.85
Seattle	2.70	2.70	2.65
Dallas	2.40	2.40	2.05f.o.b
Atlanta	**2.40**	2.30	2.40
Cincinnati (f. o. b.)	2.22	2.22	2.32
Los Angeles	2.66	2.66	2.56
Baltimore	2.65	2.65	2.50
Birmingham	2.60	2.60	2.40
Kansas City, Mo.	2.30	2.40	2.10f.o.b
Montreal (f. o. b.)	1.41	1.41	2.22
Philadelphia	2.31@2.41	2.31@2.41	2.40
St. Paul (f. o. b.)	2.22	2.22	2.22
Toledo (f. o. b.)	2.20	2.20	2.20

Current mill-prices per barrel, in carloads, without bags, f.o.b., to contractors:

Buffington, Ind.	$1.80	Richard City, Tenn.	$1.85
Universal, Pa.	1.80	North Birmingham, Ala.	1.45
Steelton, Minn.	1.85	Leeds, Ala.	1.65
Fordwick, Va.	2.05	Hannibal, Mo.	1.90
Mitchell, Ind.	1.90	Lehigh Valley District	1.75
Iola, Kan.	1.85	Wyandotte, Mich.	1.65
Mason City, Ia.	1.80	Alpena, Mich.	1.60
La Salle, Ill.	1.90	Kingsport, Tenn.	2.05
Hudson, N. Y.	1.75	Clinchfield, Ga.	1.65

E. N.-R. Prices of Construction Materials

WIRE REINFORCEMENT FOR CONCRETE—Price per 100 sq.ft. in carloads at mills; from warehouses per 100 sq.ft. in lots of 10,000 sq.ft. or over.

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse: New York*	St. Louis	Dallas	San Francisco
032	22	$0.99	$1.01	$1.39	$1.06	$1.13	$1.22
049	28	1.26	1.29	1.76	1.35	1.38	1.55
068	35	1.54	1.58	2.18	1.66	1.67	1.91
093	45	1.98	2.03	2.79	2.13	2.00	2.46
126	57	2.45	2.51	3.45	2.63	2.55	3.03
153	68	2.92	2.99	4.13	3.14	3.15	....
180	78	3.35	3.43	4.73	3.60	3.47	....
245	103	4.43	4.53	6.24	4.75	4.58	....
287	119	5.12	5.24	7.20	5.50	5.26	6.35
336	138	5.93	6.07	8.36	6.37	6.11	....
395	160	6.88	7.04	9.68	7.38	7.12	....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher.

*Delivered to job. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq.ft.

BARS, CONCRETE REINFORCING—Pittsburgh and Birmingham prices are for large mill lots, per 100 lb., f.o.b. mill. In other cities listed, prices are per 100 lb., for bars delivered from warehouse stocks.

ROLLED FROM BILLETS

Inches	Pittsburgh	Birmingham	Warehouse: New York*	Chicago	St. Louis	Dallas	San Francisco
¼ and larger	$1.95	$2.00	$3.25*	$2.30@2.75	$3.15	$3.75	$2.25
⅜	2.05	2.10	3.35*	2.40@2.85	3.25	3.95	2.35
½	2.15	2.20	3.45*	2.50@2.95	3.35	3.95	2.45
⅝	2.35	2.40	3.65*	2.70@3.15	3.55	4.10	2.65
¾	2.95	3.00	4.25*	3.30@3.75	4.15	4.75	3.25

For standard classification of extras for size and cutting of steel bars, see bar card of July 15, 1923. *250 to 3,999 lb.

EXPANDED METAL LATH—Per 100 sq.yd., painted, delivered to job in less-than-carload lots:

Weight in Pounds per Sq. Yd.	New York	Birmingham	Chicago	St. Louis	San Francisco	Dallas
2.2	$19.00	$19.50	$16.00	$21.00	$18.50	$21.50
2.5	20.00	21.50	17.00	22.00	19.50	24.00
3.0	22.00	24.50	19.00	24.50	22.00	....
3.4	23.50	27.50	20.50	26.00	24.00	30.50

BRICK—Contractors price, delivered, per M, is as follows:

	Common	Paving F.O.B. 3x8¼x4-in.	Paving F.O.B. 3½x8¼x4-in
New York	$17@20	$45.00	$51.00
Chicago	12.00	42.00	45.00
St. Louis, salmon	14.00	40.00 del.	42.50del.
Denver, salmon	10@12	.....	.....
Dallas	14.50	35.00	.....
San Francisco	13.00	.....	.....
Los Angeles	11.00	.....	.....
Boston	17.50	45.00 del.	51.00del.
Minneapolis	13.50	.....	.....
Kansas City	14.00	.....	33.00
Seattle	15.00	.....	62.50del.
Cincinnati	18.00	40.00	45.00
Montreal	20.33	100.00*	.....
Detroit	15.50	35.50	38.50
Baltimore	15.00	40.00	45.00
Atlanta	13.75	40.00	.....
New Orleans	15.00	60.00	75.00
Birmingham	15.00	50.00 del.	60.00del.
Philadelphia	17.00	40.00	46.00
Pittsburgh	17.00	.....	.....
Cleveland	14@16	.....	.....

*Imported.

HOLLOW TILE—Price of hollow building tile per block delivered to contractors in lots of 2,000 pieces or over:

	4x12x12	6x12x12	8x12x12	10x12x12	12x12x12
Boston	$0.0775	.....	$0.138	.....	$0.2375
Minneapolis	.0842	.....	.1476	.....	.2441
Cincinnati	.074	.....	.136	.....	.205
Kansas City	.088	.....	.158	.....	.242
Denver	.085	.....	.155	.....	.22
Seattle	.10	.....	.18	.....	.26
Los Angeles	.085	.....	.172	.....	.285
New Orleans	.09	.....	.165	.....	.245
Detroit	.092	.....	.174	.....	.244
Montreal	.12	.....	.22	.....	.315
Baltimore	.095	.....	.175	.....	.232
Atlanta	.0724	.....	.1358	.....	.2021
Dallas	.0985	$0.1205	.1785	$0.284	.....
Birmingham	.09	.127	.174	.....	.....
Pittsburgh	.068	.....	.1175	.....	.1726
Cleveland	.06	.....	.135	.....	.....
New York	.0973	.1459	.1824	.2313	.3084
Chicago	.076	.104	.142	.182	.202
Philadelphia	.11	.....	.22	.....	.34
St. Louis	.078	.105	.145	.175	.210
San Francisco	.108	.156	.255	.....	.....
Perth Amboy, N. J. (f.o.b.)	.....	.....	.....	.252	.312

STRUCTURAL MATERIAL—Pittsburgh and Birmingham prices are for large mill lots, per 100 lb., f.o.b. mill. At other cities listed, quotations apply on less-than-carload lots delivered from warehouse stocks:

	Pittsburgh	Birmingham	Warehouse: New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$1.85	$2.05	$3.30*	$3.50	$3.25	$3.10	$3.25
Channels, 3 to 15 in.	1.85	2.05	3.30*	3.50	3.25	3.10	3.25
Angles, 3 to 6 in., ¼ in. thick	1.85	2.05	3.30*	3.50	3.25	3.10	3.25
Tees, 3 in. and l'rg'r.	1.85	2.05	3.30*	3.50	3.25	3.10	3.25
Plates, ¼ in. thick and heavier	1.85	2.05	3.30*	3.50	3.25	3.10	3.25

*250 to 3,999 lb.

RIVETS—The following quotations are per 100 lb., full packages, delivered from warehouse:

ROUND-HEAD STRUCTURAL

	Pittsburgh Mill	Warehouse: New York	Chicago	St. Louis	San Francisco	Dallas
½ in.	$2.90	$5.00	$3.60	$3.75	$5.75	$5.00

CONE-HEAD BOILER

½ in.	$3.00	$5.00	$3.60	$3.75	$5.75	$5.00

NAILS—The following quotations are per 100 lb. keg delivered from warehouse stocks, also Pittsburgh mill base:

	Pittsburgh Mill	Birmingham	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.55@$2.65	3.10	$3.10	$3.60	$4.00	$2.75	$4.95
Cut	2.80	3.30	....	5.00	5.00	....	5.00

SHIP SPIKES—Current prices per 100 lb. delivered from warehouse:

In.	San Francisco Galv.	San Francisco Black	Seattle Black
½	$7.55	$5.80	$7.75
⅝	6.85	5.10	5.65
¾	6.70	4.95	5.50

Pittsburgh base in lots of 200 kegs or more, $3.00 per 100 lb.

PREPARED ROOFINGS—Slate-surfaced roofing in rolls weighing 85 to 90 lb., costs $2.50 per square to contractors in carloads, f.o.b., New York.

Single shingles, slate finish, cost $6.12½ per square (sufficient to cover 100 sq.ft.) in carloads, f.o.b., New York.

Strip shingles (4 in 1) f.o.b. New York, in carloads to contractors, are $5.00 per square for the hexagonal shape, with Underwriters' label.

ROOFING MATERIALS—Prices f.o.b. New York, to contractors in carloads:

Tar felt per, 100 lb.	$3.27½
Asphalt coating, per gal.	.40
Asphalt felt, per 100 lb.	3.25

WINDOW GLASS—United inches 25, bracket size 6x8 to 10x15, discount from jobbers' list (Mar. 1, 1913) at New York warehouses:

Single Thickness		Double Thickness	
AA	83%	AA	83%
A	88%	A	88%
B	89%	B	89%

SHEETS—Quotations are per 100 lb. in various cities delivered from warehouse stocks, also the base quotations at mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$1.90@$2.10	$3.60	$3.50	$3.85	$3.90*
No. 12	1.95@ 2.15	3.65	3.55	3.90	3.95*
No. 14	2.05@ 2.20	3.70	3.60	3.95	4.00*
No. 16	2.15@ 2.30	3.80	3.70	4.10	4.10*
Black					
Nos. 18 to 20	2.45@ 2.55	4.05	3.75	4.75	4.00
No. 22	2.60@ 2.70	4.20	3.90	4.90	4.15
No. 24	2.65@ 2.75	4.25	3.95	4.95	4.20
No. 26	2.75@ 2.85	4.35	4.05	5.00	4.30
No. 28	2.90@ 3.00	4.50	4.20	5.20	4.45
Galvanized					
No. 10	2.80@2.90	4.40	4.10	4.60	4.25
Nos. 12 to 14	2.90@3.00	4.50	4.20	4.70	4.35
No. 16	3.00@3.10	4.60	4.30	4.90	4.45
No. 18	3.15@3.25	4.75	4.45	4.95	4.60
No. 20	3.30@3.40	4.90	4.60	5.10	4.75
No. 22	3.35@3.45	4.95	4.65	5.15	4.80
No. 24	3.50@3.60	5.10	4.80	5.30	4.95
No. 26	3.75@3.85	5.35	5.05	5.55	5.20
No. 28	4.00@4.10	5.60	5.30	5.80	5.45

Extra for corrugated sheets, 15c. per 100 lb. *250 to 3,999 lb.

LINSEED OIL—These prices are for raw oil in barrels, f.o.b. in 1 to 4-bbl. lots:

	New York	Chicago	Minneapolis
Per pound	$0.11	$0.11	$0.115

E. N.-R. Prices of Construction Materials

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry	In Oil
Red	$13.25	$14.75
White	13.25	13.25

Lumber

Prices Are Per Thousand Feet, Board Measure

San Francisco—Prices of rough Douglas fir, No. 1 common, at yards; prices delivered to contractor at site of job, $1.50 to $5 per M. ft. additional:

	10-16-18 and 20 Ft.	22 and 24 Ft.
3x3 and 4	$28.00	$29.00
3x6 and 8	28.00	29.00
3x10 and 12	28.00	29.00
3x14	31.00	33.00

Chicago—Prices, f.o.b., in carloads, per M. ft. b.m.; prices delivered to job in truckloads from stock, $10 per M. ft. additional:

	20 Ft. and Under No. 1 Long-Leaf Yellow Pine	Up to 32 Ft. No. 1 Douglas Fir
3x4 to 8x8	$38.00	$39.50
3x10 to 10x10	46.50	39.50
3x12 to 12x12	56.50	39.50
3x14 to 14x14	.....	39.50
3x16 to 16x16	.....	40.50

New York—Prices per M. ft., b.m., wholesale, for rough, long-leaf, yellow-pine timbers in quantities of 35,000 ft. or more, within lighterage limits:

	20 Ft. and Under Long-Leaf Yellow Pine	22-24 Ft. Long-Leaf Yellow Pine
3x4 to 8x8	$41.00@$43.00	$42.00@$44.00
3x10 to 10x10	48.00@ 50.00	49.00@ 51.00
3x12 to 12x12	55.00@ 57.00	56.00@ 58.00
3x14 to 14x14	63.00@ 65.00	64.00@ 66.00
3x16 to 16x16	75.00@ 77.00	76.00@ 78.00

Other Cities—Delivered to job:

	8x8-In. x 20 Ft. and Under, Rough				3x12 to 12x12-In. 20 Ft. and Under, Rough	
	Pine*	Fir†	Hem-lock	Spruce	Pine*	Fir†
Boston	$48.00	$47.00	$47.50	$50.00	$56.25	*$54.00*
Seattle	.....	25.00	.....	.....	.....	25.00
New Orleans	40.00	56.00	.....	.....	61.00	61.00
Baltimore	36.00	50.25	54.00	61.25	75.00	50.50
Cincinnati	33.00	46.00	44.00	44.00	37.00	50.00
Montreal	50.00	55.00	.....	.....	49.00	48.00
Los Angeles	.....	39.50	.....	32.00	.....	39.50
Denver	.....	31.25	.....	.....	.....	32.25
Minneapolis	53.00	48.25	36.25	.....	55.00	49.25
Atlanta	31.00	.....	.....	.....	45.00	.....
Dallas	57.50	.....	.....	.....	57.50	.....
Kansas City, Mo.	39.00	39.75	.....	.....	52.00	39.75
Birmingham	35.00	.....	.....	.....	55.00	.....
Philadelphia	55.00	37.00	42.00	43.00	65.00	37@38
Detroit	55.00	55.00	.....	.....	65.00	65.00
St. Louis	43.00	38.00	38.00	43.00	53.00	39.00

	1x10 In. x 16 Ft. and Under, Rough			2x10 In. x 16 Ft. T. & Gr.	
	Pine*	Fir†	Hem-lock	Pine*	Fir†
Boston	$43.50	$42.50	$44.00	$48.50	$47.50
Seattle	.....	24.00	.....	.....	25.50
New Orleans	36.00	.....	.....	44.00	.....
Baltimore	56.00	45.00	45.00	35.00	48.00
Cincinnati	27.00	32.00	30.00	28.00	45.00
Montreal	45.00	48.00	40.00	85.00	70.00
Los Angeles	.....	33.50	.....	.....	47.50
Denver	.....	32.25	31.25	.....	31.25
Minneapolis	48.00	42.00	35.75	48.00	43.00
Atlanta	40.00	.....	.....	40.00	.....
Dallas	.....	.....	.....	57.50	.....
Kansas City, Mo.	50.75	39.75	.....	42.00	36.75
Birmingham	36.00	.....	.....	48.00	.....
Philadelphia	30.00	36.50	36.00	50.00	36.50
Detroit	40.00	.....	.....	38.00	.....
St. Louis	43.00	.....	.....	*31.00*	.....

*Long-leaf yellow pine. †Douglas fir.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

Miscellaneous

STEEL SHEETPILING—The base price f.o.b. Pittsburgh for large mill lots is $2.25@$2.35 per 100 lb.

CONCRETE BLOCKS—Standard, 8x8x16-in., delivered to job, each:

Denver	$0.22	St. Louis	*$0.18*
Detroit	.15	Boston	18@.20
New Orleans	.22	Minneapolis	.14
Brooklyn and Queens	.16@.18	Philadelphia	18@.25
Pittsburgh	.18	Cleveland	17@.18

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized, are as follows:

	Eastern Territory New York and East of Missouri River
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope (add to list)	12½%

California, Oregon, Nevada and Washington: Discount 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arizona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¼-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¼-in., 8-ft.; ⅜-in., 6-ft.; ½-in., 4½-ft.; ⅝-in., 3¼-ft.; ¾-in., 2-ft. 10-in.; 1-in., 2-ft. 4-in. Following are prices per pound for ¼-in. and larger delivered in 1,200-ft. coils:

Boston	$0.25	New Orleans	$.23½
New York	.24	Los Angeles	.25
Chicago	.21	Seattle	.21½
Minneapolis	.23	St. Louis	.21½
San Francisco	.21½	Montreal	.24½
Atlanta	.25	Detroit	.24½
Denver	.24	Baltimore	.22½
Cincinnati	.21	Kansas City	.25
Dallas	.21	Birmingham	35@.40
Philadelphia	.25	Cleveland	.30

EXPLOSIVES—Prices per pound for dynamite delivered in small lots:

	Gelatin 40%	Gelatin 60%
New York (Special gelatin in case lots.)	$0.26	$0.2825
Boston	.25	.275
Kansas City	.2025	.2225
Seattle	.16	.185
Chicago (Quantities above 500 lb., but less than a ton.)	.195	.22
Minneapolis	.1967	.2173
St. Louis	.2075	.2275
Denver (f.o.b.)	.1925	.2150
Dallas	.2325	.2525
Los Angeles (f.o.b. San Fernando Arsenal)	.1875	.2225
Atlanta	.22	.245
Baltimore	.215	.2375
Cincinnati	.22	.245
Montreal	.195	.22
Birmingham (f.o.b.)	.155	.185
New Orleans	.235	.26
San Francisco	.1625	.1925
Philadelphia	.215	.24

CHEMICALS—Water and sewage treatment chemicals, round lots in the New York market:

Sulphate of aluminum, iron free, in bags, per 100 lb.	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb.	5.30@ 5.50
Soda ash, 58%, in bags, per 100 lb.	1.32@ 1.35
Chlorine, liquid, cylinders, per lb.	.05½@ .08
Hypochlorite of lime (bleaching powder) in drums, per 100 lb.	2.00@2.10*

* F.o.b. works.

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carload lots of 36,000 lb. or 18 tons:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.735
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.32
Cincinnati	.29	St. Louis	.43
Cleveland	.19	St. Paul	.60
Denver	1.15*		

* Minimum carload for structural steel, 50,000 lb.; for other iron or steel products, 80,000 lb.